OPERATION & MAINTENANCE

HANDBOOK

MODEL 108L
PULSE GENERATOR

DATAPULSE
DIVISION OF DATAPULSE INCORPORATED

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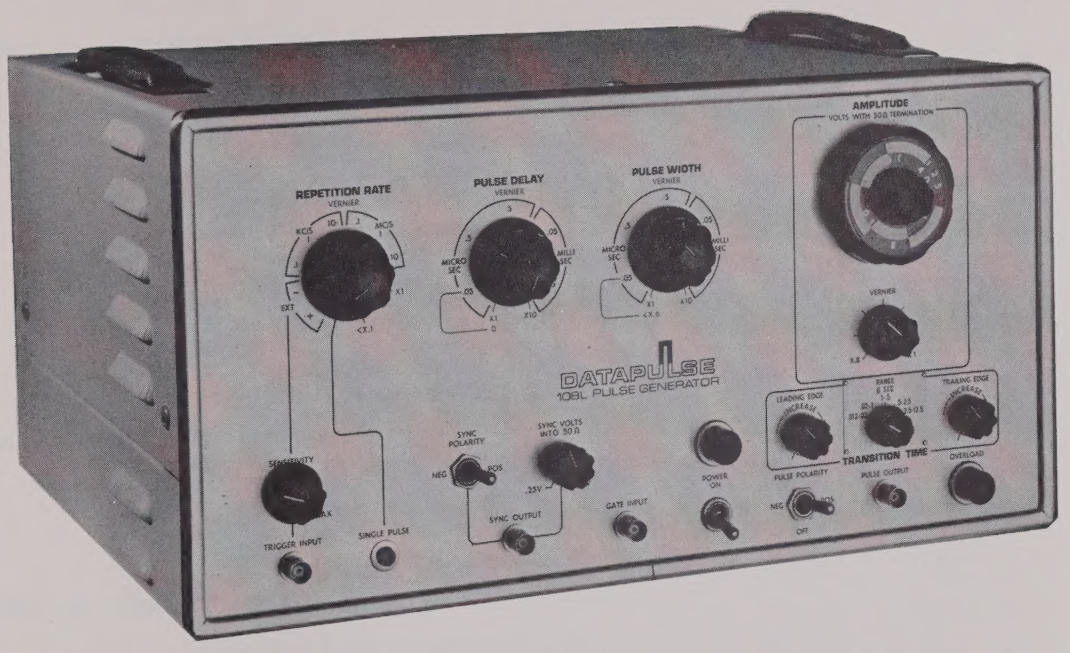
509 HINDRY AVENUE, INGLEWOOD, CALIF.



MODEL 108L PULSE GENERATOR

The Datapulse Model 108L Pulse Generator is an all solid-state, high power source of variable parameter pulses designed for a wide range of test applications. It is similar to the Model 108 with the exception that variable transition time with separate controls for rise and fall times has been added for increased versatility.

The instrument features clean, high power pulses, high duty cycle capablity, variable rise and fall times and high repetition rates. In addition, it is capable of generating clean, wide, low power pulses at low repetition rates. Design techniques developed for military equipment assures stable and reliable performance.

This instruction manual contains general and detailed instructions for operation and maintenance of the Model 108L. A complete understanding of its contents will contribute to a full utilization of the broad capabilities of the instrument.

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SCHEMATICS

Drawing No.	Description
41000-104	Block Diagram - Model 108L
40000-052	Schematic - Power Supply
40000-053	Schematic - Attenuator 50 dB
40000-055	Schematic - Front End
40000-096	Schematic - Power Supply Output Amplifier
40000-097	Schematic - Output Amplifier

ADDENDA AND ERRATA

First Printing: August 1966

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SECTION I
SPECIFICATIONS

1.1 REPETITION RATE

Continuously variable from 10 cps to 10 mc, covered in six decade ranges. Full scale accuracy of each range is nominally ±5% (10% maximum). Jitter is less than 0.1%.

1.2 EXTERNAL TRIGGER

Sync output occurs at a fixed delay of approximately 130 nanoseconds from external trigger. Unit operates at 0 to 10 mc from ±5 volt pulses (30 nanoseconds, minimum duration) or at 10 cps to 10 mc from 4 volts rms sine waves. Polarity and sensitivity controls provide for reliable triggering at any point on the input waveform more than 5 volts above or below average dc level. Input impedance is approximately 5,000 ohms. Maximum signal level which may be applied with sensitivity control at maximum is ±10 volts.

1.3 SINGLE PULSE

Operation of a front panel pushbutton provides one cycle of output.

1.4 GATED OPERATION

External gate signal levels more negative than minus 6 volts block main pulse output, no connection or levels more positive than minus 2 volts enable. Gate signal must furnish approximately 3 milliamperes during disabling. Levels greater than ±25 volts may not be applied.

1.5 SYNC OUTPUT

Selectable either positive or negative, variable from approximately 0.25 volts to at least 6 volts into 50 ohms (approximately 15 volts open circuit, 10 volts into 100 ohms). Pulse width is approximately 20 nanoseconds, rise time approximately 7 nanoseconds.

1.6 MAIN PULSE DELAY (of minimum rise time leading edge from sync output)

Continuously variable from 0 to 5 milliseconds covered in five decade ranges. Maximum delay duty cycle is greater than 50% of pulse period, externally or internally triggered.

1.7 MAIN PULSE DURATION (at 50% amplitude point of minimum rise time waveform)

Continuously variable from less than 30 nanoseconds to 5 milliseconds, covered in five decade ranges. See main pulse output for duty cycle limitations.

1.8 JITTER, ACCURACY, AND STABILITY (delay and duration)

Jitter is less than 0.1% plus 0.5 nanoseconds. Full scale accuracy of each range is nominally ±5% (±10% maximum). Stability (typical change with line voltage variation of ±10%) is better than ±0.2%.

1.9 MAIN PULSE OUTPUT

Direct coupled, selectable as positive, off, or negative.

1.9.1 Amplitude

Continuously variable from 0.2 volts to 50 volts into 50 ohms (0 to 50 dB attenuation) covered in 2 dB steps plus fill-in. Steps are calibrated in volts into 50 ohms, accuracy approximately ±5%. Line voltage variations have negligible effect on pulse amplitude.

1.9.2 Baseline Dc Level

Less than 1 millivolt at full amplitude, reducing with attenuation, except for the effect of leading edge and trailing edge waveform aberrations at high duty cycles above 2 mc (which are typically less than 2% of pulse amplitude).

1.9.3 Source and Load Impedance

Output is a voltage source (pulse-top diode clamped) presented through a constant impedance 50 ohm attenuator, i.e., source impedance is approximately 50 ohms at amplitudes of 10 volts and less. Unit is designed for operation into a 50 ohm load and is overload protected against output shorts or loads less than 40 ohms.

1.9.4 Duty Cycle and Overload Protection

Maximum pulse width duty cycle is 50% (except 40% maximum with pulse widths greater than 2 milliseconds). Automatic overload protection against excessive duty cycle, output shorts, or loads less than 40 ohms causes pulse distortion, reduces average current by disabling output for approximately one-second periods, and is indicated by a panel lamp. Operation returns to normal when overload condition is corrected.

1.9.5 Back Voltages

Opposite polarity voltages in excess of approximately 500 millivolts are diode clamped to ground, fully protecting output transistors unless more than approximately 300 milliamperes are provided by the back voltage source. Same polarity voltages are diode clamp limited to the pulse amplitude and are further limited by attenuator power ratings to 35 volts dc maximum (10 volts dc maximum at pulse amplitudes less than 16.5 volts).

1.9.6 Rise And Fall Time (with 50 ohm resistive load)

Continuously variable from 12 nanoseconds to 12.5 microseconds, covered in five ranges (12-20 nanoseconds, 20-100 nanoseconds, 0.1-0.5 microseconds, 0.5-2.5 microseconds, 2.5-12.5 microseconds), independently variable within each range. Rise time linearity between the 10% and 90% amplitude points is within 2% except on the 12-20 nanosecond range (within 5% at 12 nanoseconds). Linearity is defined as the maximum deviation, expressed as a

percent of 10% to 90% amplitude of the actual transition waveform from a straight reference line with its slope and position chosen to minimize deviations over the 10% to 90% amplitude range.

1.9.7 Waveform Aberrations (with properly connected 50 ohm resistive load)

Overshoot, undershoot, ring and top slope are typically ±1% (±3% maximum) at amplitudes greater than 5 volts, and transition times greater than 20 nanoseconds, increasing to ±7% maximum at 200 millivolts, and typically ±3% at transition times of 12 nanoseconds.

1.10 POWER

105-125 volts, 50/60 cycle ac, approximately 200 watts maximum.

1.11 OPERATING TEMPERATURE

Designed for operation at 0 to 50° Centigrade ambient.

1.12 PHYSICAL

Aluminum front panel with etched black and red markings, beige cabinet with quick-release top and bottom covers, forced air cooling with filter, 8-3/4" H x 17" W x 15-1/4" D. May be rack mounted (8-3/4" H x 19" W panel space) by specifying Model 108LR or by installing Type 1002 Rack Mounting Set. Net weight is approximately 33 pounds, shipping weight approximately 45 pounds. All signal connectors are BNC type.

1.13 ACCESSORIES FURNISHED

One operation and maintenance manual, 8 ft. line cord with NEMA 3-prong plug.

1.14 ACCESSORIES AVAILABLE

4 ft. 50 ohm cable with BNC connectors (Type 4048), 50 ohm 25 watt termination (Type 2003), rack mounting set (Type 1002), additional manual copies.

SECTION II
OPERATING INSTRUCTIONS

2.1 DESCRIPTION OF CONTROLS AND CONNECTORS

2.1.1 Power Switch

The POWER ON toggle switch connects or disconnects ac input voltage to transformer primaries and fan motor within the instrument. The pilot lamp above the switch lights when the power is on.

2.1.2 Repetition Rate

The black REPETITION RATE knob selects the repetition rate range. There are six ranges, each covering one decade of frequency. One position is provided for single pulse operation, one position for external triggering with positive going waveforms, and one position for triggering with negative going waveforms.

The red vernier knob provides continuous fill-in between ranges of the repetition rate control. With this control fully clockwise, the instrument is calibrated at the frequency shown by the REPETITION RATE control.

2.1.3 Single Pulse

Each depression of the SINGLE PULSE pushbutton initiates one cycle of output when REPETITION RATE control is in the single pulse position.

2.1.4 Trigger Input

The TRIGGER INPUT BNC connector accepts a pulse or sine wave to slave Schmitt trigger to outside signal when REPETITION RATE control is in EXT position.

2.1.5 External Sensitivity

The SENSITIVITY knob adjusts the level on an external signal at which the instrument triggers.

2.1.6 Sync Output

The SYNC OUTPUT BNC connector provides a narrow output pulse on each cycle which serves as a zero time reference for the delay circuit.

2.1.7 Sync Polarity

The SYNC POLARITY toggle switch controls the polarity of the sync output pulse.

2.1.8 Sync Volts into 50 Ohms

The SYNC VOLTS INTO 50 OHMS control knob adjusts the amplitude of the sync output pulse. When the sync pulse is loaded with 50 ohms the amplitude is continuously variable from 0.25 volts to more than 6 volts.

2.1.9 Gate Input

The GATE INPUT BNC connector provides an input for an external gating signal. When an applied dc level is more negative than -6 volts, output pulses are disabled. Maximum input is ±25 volts.

2.1.10 Pulse Delay

The black PULSE DELAY knob selects the delay range. There are five ranges, each covering one decade.

The red vernier knob provides a continuous fill-in between ranges of the pulse delay control. With this control fully counterclockwise the instrument is calibrated at the delay shown by the PULSE DELAY control.

2.1.11 Pulse Width

The black PULSE WIDTH control selects the width range. There are five ranges each covering one decade.

The red vernier knob provides continuous fill-in between ranges of the control. With this control fully counterclockwise the instrument is calibrated at the width shown by the PULSE WIDTH control. NOTE: On very narrow pulses, increasing the rise time of the output pulse will cause the output amplitude to drop, triggering the overload protection circuit.

2.1.12 Amplitude Range--Volts with 50 Ohm Termination

The two concentric AMPLITUDE controls indicate the magnitude of the output voltage when the vernier control is in the clockwise position and the output is terminated with 50 ohms.

The black vernier knob provides continuous fill-in between ranges of the amplitude range control. When this control is in the fully clockwise position the instrument is calibrated at the setting of the range control.

2.1.13 Pulse Polarity

The three position PULSE POLARITY toggle switch allows the output pulse to be either NEG, POS, or OFF.

2.1.14 Transition Time Controls

The TRANSITION TIME RANGE selector determines the range of the output pulse transition times. There are five ranges to allow coverage from 12 nanoseconds to 12.5 microseconds.

The LEADING EDGE knob provides continuous variation of leading edge transitiom time within the range set by the TRANSITION TIME RANGE selector.

The TRAILING EDGE knob provides continuous variation of trailing edge transition time within the range set by the TRANSITION TIME RANGE selector.

2.1.15 Pulse Output

The PULSE OUTPUT BNC connector couples the variable parameter pulse to an external load.

2.1.16 Overload

The OVERLOAD lamp lights when the output is terminated with low resistive loads or is short circuited. NOTE: On very narrow pulses, increasing the rise time of the output pulse will cause the output amplitude to drop, triggering the overload protection circuit.

2.1.17 Fuse

Two amp fast blow fuse (located on rear panel) protects against ac overload.

2.1.18 Power Input

The 3-prong power input recessed male connector (located on rear panel) accepts a NEMA 3-wire line cord to supply ac power from the line.

2.2 PLACING IN OPERATION

2.2.1 Preliminary Settings

a. Set REPETITION RATE control to 0.1 MC/S, vernier clockwise.

b. Set PULSE DELAY control to 0.05 MICROSEC, vernier counterclockwise.

c. Set PULSE WIDTH control to 0.05 MICROSEC, vernier clockwise.

d. Set TRANSITION TIME controls counterclockwise.

e. Set AMPLITUDE to 20 volts, vernier clockwise.

f. Load PULSE OUTPUT with 50 ohms.

g. Set PULSE POLARITY to NEG.

h. Set POWER switch to ON. Pilot should light.

i. Sync oscilloscope from SYNC OUTPUT. Set scope sweep speed to 0.1 μs/cm, vertical sensitivity to 10v/cm.

j. Compare pulse output with that shown in Figure 2-1.

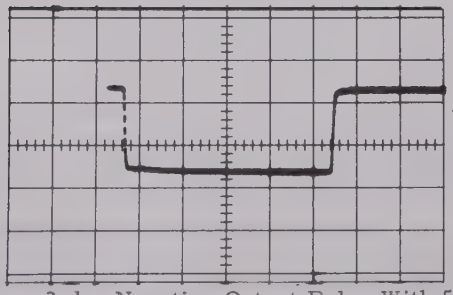


Figure 2-1. Negative Output Pulse With 50 Ohm Load, 0.1 μS/cm, 10 volts/cm.

k. Switch PULSE POLARITY to POS and compare pulse output with that shown in Figure 2-2.

l. If instrument fails to function properly, refer to Paragraph 4.3.

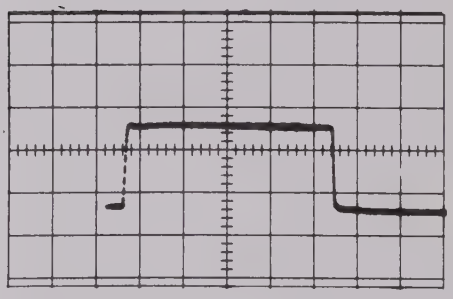


Figure 2-2. Positive Output Pulse With 50 Ohm Load, 0.1 μS/cm, 10 volts/cm.

2.3 OPERATING CONSIDERATIONS

2.3.1 External Triggering

When the REPETITION RATE control is in the (-) EXT or (+) EXT position, the Model 108L can be driven from an external source provided that the driving signal is greater than 5 volts in amplitude and greater than 35 nanoseconds in width. As the synchronizing circuit is a Schmitt trigger with 10 cps frequency response, the slope and rise time of the driving waveform is not critical. In (-) EXT position the circuit will trigger on the negative going slope of the input waveform, and in the (+) EXT position the circuit triggers on the positive going slope.

When externally driving the Model 108L, always set the SENSITIVITY control to the full counterclockwise (minimum) position before application of the driving waveform. This will insure that no damage will be done to the Schmitt trigger should the driving waveform be greater than ±10 volts in amplitude. With the external signal applied to the external TRIGGER INPUT jack and the SENSITIVITY control in the minimum position, adjust sensitivity clockwise until stable triggering is obtained. Do not advance the SENSITIVITY control any more than is necessary as the lowered input impedance and attendant overdrive may cause severe distortion of the input signal which can result in unstable multiple triggering of the Model 108L.

CAUTION

Always insure that the driving signal is less than ±10 volts when the SENSITIVITY control is in the maximum (clockwise) position to avoid damage to the Schmitt trigger circuit.

As the input to the synchronizing circuit is ac coupled, the reference level presented will vary as a function of the duty cycle and/or amplitude at the driving waveform. Therefore, when either of these parameters is changed, the SENSITIVITY control must be readjusted to provide triggering at the same point on the input signal.

2.3.2 Duty Cycle Limitations

Average power supply current available limits the maximum pulse width duty cycle of the Model 108L to 50%. At duty cycles in excess of 50% the power supply will go out of regulation and cause considerable pulse distortion and reduced amplitude, causing the unit to go into overload.

The delay and width controlling one-shot multivibrators have duty cycle capabilities exceeding 70%.

In order to minimize confusion resulting from excessive duty cycle, it is recommended that the PULSE DELAY and PULSE WIDTH controls be set to their minimum positions when frequency is being changed, and then set to the desired settings upon completion of frequency shift. A common error is to have excessive delay duty cycle without realizing it.

CAUTION

When observing or making any corrections to the output circuitry (including its power supply) it is necessary that the PULSE POLARITY switch be on OFF or NEG. The unit may be permanently damaged otherwise.

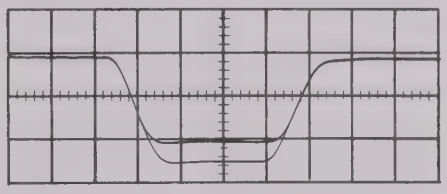
2.3.3 Transition Time Control

The Model 108L features an extremely versatile rise and decay time control. The leading and trailing edge transition times may be independently varied over a range of approximately 5:1.

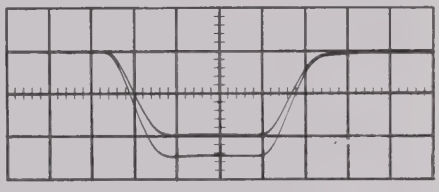
The TRANSITION TIME RANGE control varies both the rise and decay times simultaneously in 5 steps from less than 12 nanoseconds to greater than 12.5 microseconds. The TRANSITION TIME LEADING EDGE and TRAILING EDGE controls are independent and provide continuous fill-in within a transition time range. With this form of control it is possible to produce waveforms with leading edge transition time differing from trailing edge transition time by a ratio of greater than 5:1. This enables the Model 108L to generate useful functions such as ramps, sawteeth, triangles and trapezoids, where required.

2.3.4 Output Amplitude Control

Attenuation by means of the continuously variable vernier rather than range selector step control may cause a noticeable difference in output waveshape. This occurs because a constant impedance "T" attenuator is used for step control while vernier fill-in is achieved through a top clamping technique. The slope of the leading and trailing edges will remain constant when the vernier is used rather than the transition time which is fixed for step attenuation. The variation in waveshape is illustrated by Figure 2-3.



A. Output at Full Amplitude (50 volts) With Vernier Control at X1 and X0.8.



B. Output With Amplitude Control at 50 Volts and 40 Volts With Vernier at X1.

Figure 2-3. Effect of Attenuation on Waveshape.

2.3.5 Loading Considerations

One of the major advantages of the Model 108L over other pulse generators is its clean waveform at very fast rise time. In order to preserve the high degree of pulse fidelity, it is imperative that consideration be given to proper pulse termination techniques.

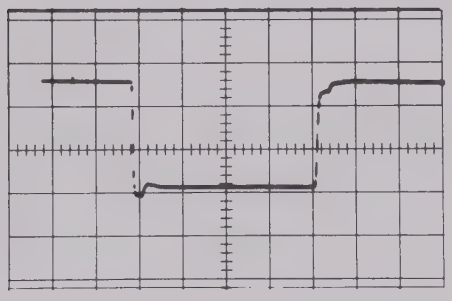
The Model 108L was designed for operation with a 50 ohm load.

The output section of the Model 108L consists of a current amplifier which supplies approximately 5% more current than is required for 50 volts into 50 ohms. This 5% (approximately 50 milliamperes) is clipped off the pulse top by clamping diodes in order to give extremely flat top pulse characteristics and clean waveshape.

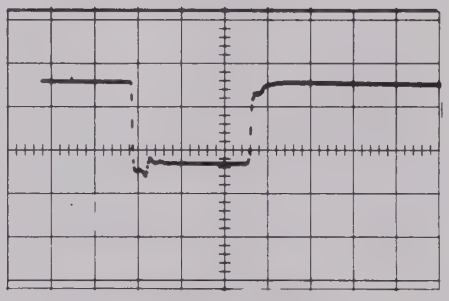
The pulse from the output amplifier is fed through approximately 7 feet of 50 ohm coaxial cable and a 50 ohm attenuator before reaching the output connector. When the attenuator is set for little or no attenuation, mismatches at the output will cause pulse deformity due to lack of source termination. See Figure 2-4 for typical waveshapes due to improper termination.

2.3.6 Cabling Considerations

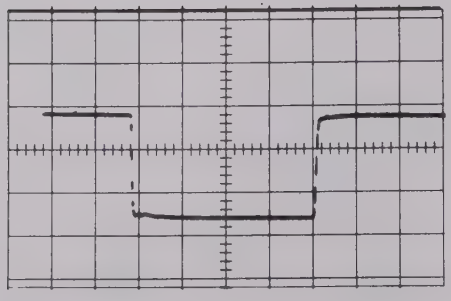
In most cases the Model 108L will be used to drive loads which are physically separated from it by several feet. In this case, it will be necessary to convey the signal by means of a 50 ohm transmission line. Preservation of low distortion waveforms is largely contingent upon the method of cabling and in proper termination of the transmission line. Clean waveforms are maintained by connecting the generator to its load with 50 ohm coaxial cable, and terminating the cable at the load into 50 ohms. Figure 2-5 illustrates the effects of poor cabling. Figures 2-6 and 2-7 illustrate proper cabling.



a. Full Amplitude Negative Pulse Loaded with 62 Ohms at the Output Connector.



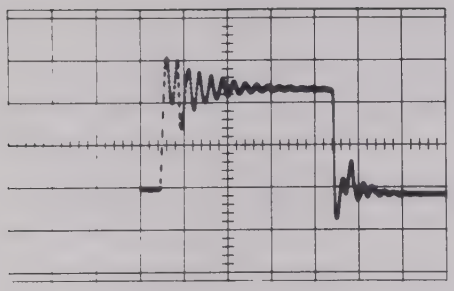
b. Full Amplitude Negative Pulse Loaded With 30 Ohms at the Output Connector.



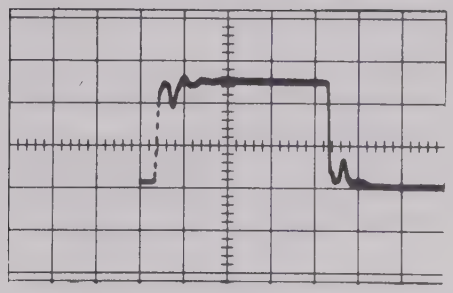
c. Full Amplitude Negative Pulse Loaded with 50 Ohms at the Output Connector. Note Absence of Overshoot & Step at Pulse Trailing Edge.

Figure 2-4. Typical Waveshapes with Attenuation.

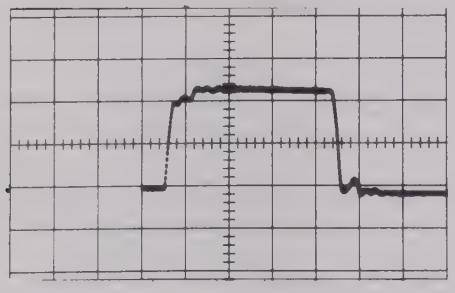
All photos were taken using a Tektronix Type 661 Sampling Oscilloscope, 100 nanoseconds/cm; 20 volts/cm.



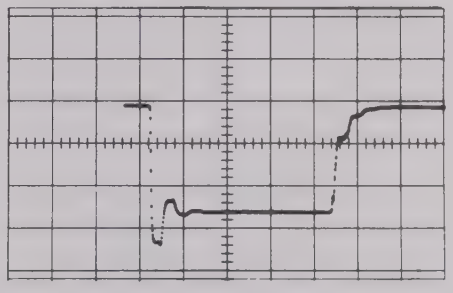
a. Positive Output at the End of 4 Feet of RG58A/U Cable Terminated With 50 Ohms at the Generator, 0.1 Microseconds/cm.



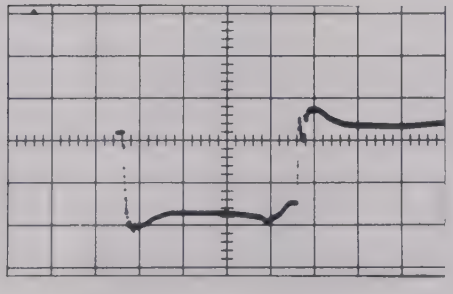
b. Positive Output at the End of 4 Feet of RG63/U Cable Terminated With 50 Ohms at the Oscilloscope, 0.1 Microseconds/cm.



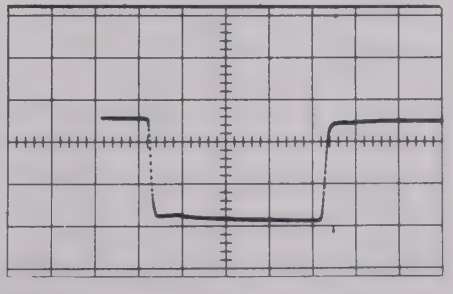
c. Positive Output Under the Same Conditions as (a), Except Rise Time Control on Generator Turned Clockwise, 0.1 Microseconds/cm.



d. Negative Output Viewed at the output Jack With a 100 Ohm Load. Reflections Due to 6 to 8 Feet of 50 Ohm Coaxial Cable Inside the Generator, 0.1 Microseconds/cm.



e. Negative Output at the End of a 4 Foot Clip Lead, Terminated With 50 Ohms at Oscilloscope, 0.5 Microseconds/cm.



f. Negative Pulse Through 4 Feet of RG58A/U Cable, Terminated into 50 Ohms at Oscilloscope, 50 Nanoseconds/cm (Proper Technique).

Figure 2-5. Effects of Poor Cabling.

All photos were taken using a Tektronix Type 661 Sampling Oscilloscope Vertical Sensitivity Set at 20 volts/cm.

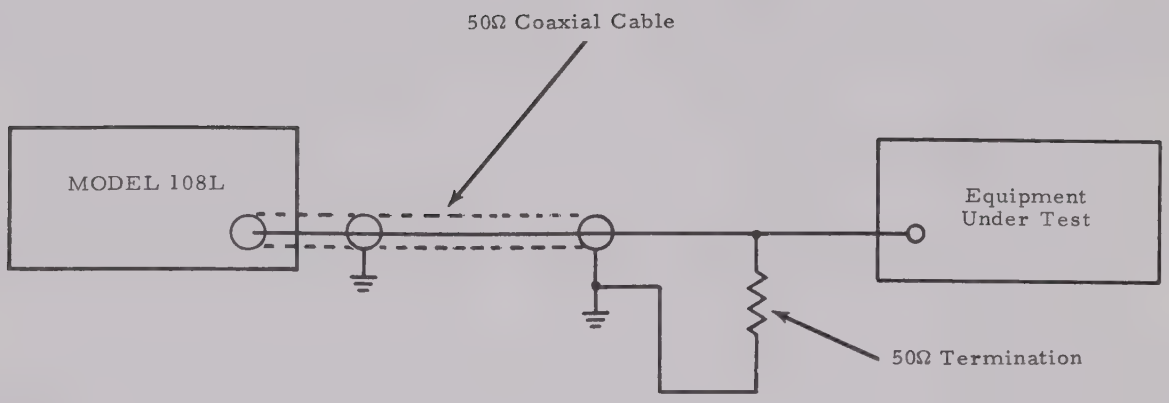


Figure 2-6. Proper Cabling Connection for Driving External Equipment.

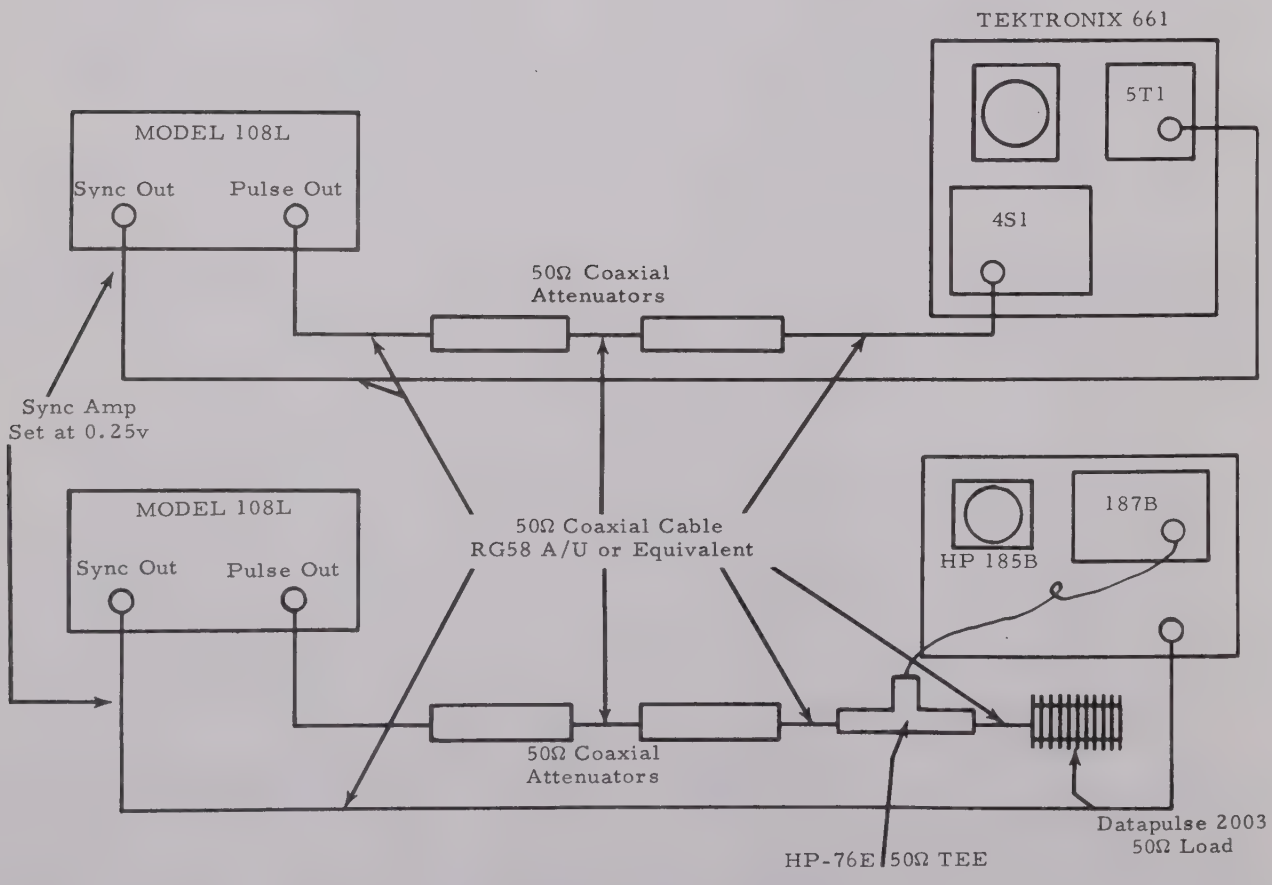


Figure 2-7. Methods of Observing Pulse Output on High Frequency Sampling Oscilloscopes.

2.3.7 Mismatch Encountered in Attenuator

Some slight change in waveshape will be encountered in the 108L output when changing amplitude due to impedance variations in the step attenuator. These aberrations may be minimized through use of the 4-30pf trimmer condenser located at the top of the attenuator and accessible when the top dust cover is removed. Optimum waveshape may require slightly different settings of this condenser at different amplitude settings. Under normal operation one setting will suffice for all amplitudes.

2.3.8 Ringing Encountered Near the Trailing Edge of the Output Pulse at Very Low Amplitude Settings

When the AMPLITUDE vernier is counterclockwise (minimum amplitude) and output pulse amplitude settings are less than one volt, some ringing will be noticed near the pulse trailing edge just prior to the transition time. This "noise" is due to a snap-off effect of the output clamp diodes which radiate strongly enough to be noticed on the output pulse. This effect may be minimized by rotating the vernier clockwise.

2.3.9 Mixing of Outputs of Several Model 108L Generators

As shown in Figure 2-8 the upper and lower levels of the output pulse are clamped; this indicates that without any attenuation between the output pulse and the output jack, the maximum excursion of external pulses is limited to these voltages. In other words only pulses of the same polarity may be mixed without previous pulse attenuation. Pulses of both polarities may be mixed when 10 dB or more of attenuation is inserted, providing a source termination of nearly 50 ohms at the generator. Caution should be taken not to exceed the output attenuator power dissipation capabilities. Looking back into the attenuator at voltage settings of 5 volts and below, the dissipation capability is approximately 4 watts.

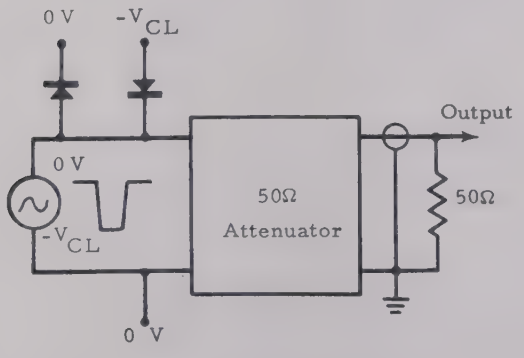


Figure 2-8. Simplified Output Circuit Schematic.

CAUTION

When observing or making any connections to the output circuitry, including its power supply, it is necessary that the PULSE POLARITY switch be on OFF or NEG to avoid permanent damage to the unit.

2.3.10 Overload Operation When Operating With Narrow Pulses

On very narrow pulses, increasing the rise time of the output pulse will cause the amplitude to drop, triggering the overload protection circuit.

2.3.11 Ventilation Requirements

The cooling fan and air filter are located on the rear panel. Leave adequate clearance (at least 2 to 3 inches) behind and at both sides of the instrument for free movement of air. The air flows through the filter and intake fan then out of the perforated side covers. It is important to keep the air intake area free of dust and small particles which could clog the filter.

2.4 SPECIAL APPLICATIONS

2.4.1 Multiple Pulse or Pulse Train Operation Using Several Model 108's

Magnetic device testing, beacon development, and digital or other pulse code simulation often require multiple pulse or pulse train signals. Multiple 108L's, when properly connected, will satisfy a broad range of requirements of this type.

Mixing the outputs of several 108L's, instead of purchasing a special purpose multipulse generator, offers many advantages. First, pulse parameters may be controlled individually; second, all pulses are selectable in polarity--a feature not always available on multipulse generators; third, such an arrangement is more versatile since the individual units may be broken down for use on other projects; and fourth, the combination of simple, proven, easily operated 108L's is more dependable than complex special equipment.

The 108L's may be driven in parallel from an external source, if sync with outside phenomena is desired, or driven in tandem (see Figure 2-9) using the sync output of one generator to externally drive the next. The first generator may be driven from an external source in the tandem arrangement also. Because of the fast rise character of the pulses and narrow widths available, pulse repetition rates approaching 50 mc may be synthesized.

The termination of interconnecting cables has an important effect on output waveform in this arrangement. Improper termination causes reflections which deteriorate waveshape and increase the rise time. However, good waveform fidelity can be obtained by inserting some measure of attenuation (the amount varying with the number of generators) at the generator end with the internal attenuator. The 50 ohm output impedance of the attenuator tends to terminate the interconnecting cables. The greatly decreased waveform distortion more than offsets the slight loss of amplitude sustained. (See Section 2.3.9.)

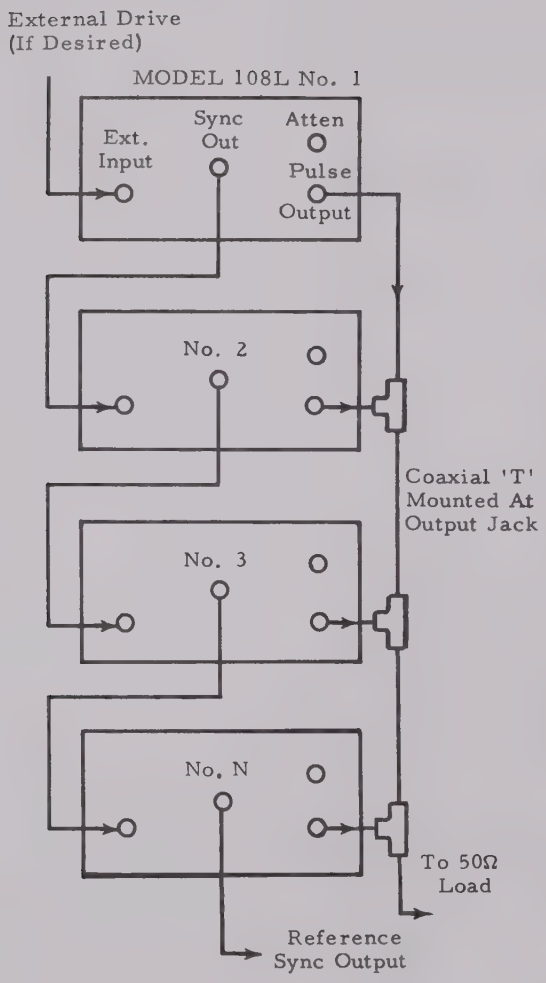


Figure 2-9.
Wiring for Multiple Pulse Output.

3.1 BLOCK DIAGRAM DESCRIPTION

3.1.1 Pulse Generating Circuit

A pulse repetition rate (W1) is developed by the internal oscillator. Either this signal or an external trigger input is applied to the Schmitt trigger circuit which provides a standardized trigger (W2). W2 is delayed 130 nanoseconds and is amplified to become the sync output pulse (W4) which is used as a zero time reference for the pulse delay function. W2 is amplified by the clock driver, provided the external gate input allows it, and triggers the delay one-shot multivibrator which produces the delay gate (W5). The trailing edge of W5 is differentiated by a pick-off amplifier yielding the delayed trigger (W6). The delayed trigger (W6) triggers the width one-shot producing the width gate (W7). The trailing edge of W7 is differentiated by a pick-off amplifier yielding W9, the trailing edge trigger. W5 is delayed and differentiated producing W8, the leading edge trigger. W9 and W8 are used to trigger the pulse forming flip-flop.

The flip-flop forms a pulse of a duration equal to the difference in time between the leading and trailing edge triggers. This negative going pulse (TP1) drives the rise and fall time control circuit, which in turn drives the output power amplifier. The power amplifier transforms the pulse (TP2) into a high power pulse (TP5) which may be attenuated by a constant impedance attenuator to a desired level between 200 millivolts and 50 volts into a 50 ohm load.

The flip-flop rise and fall time circuit and output amplifier are isolated from the front end circuitry by means of trigger coupling transformers. Either positive or negative output pulses are obtained by a reversing switch on the output leads.

3.1.2 Overload Protection Circuit

Because of the limited power dissipation, low breakdown voltages, and very short thermal time constants of the output transistors, circuitry is required to protect against possible transistor destruction due to short circuits or low resistance loads. The overload circuitry in the 108L performs two basic functions:

a. When the output drops below 40 volts during pulse time a circuit turns off the pulse forming unit until the next leading edge trigger appears.

b. A circuit immediately disables the leading edge triggers for approximately one second and turns on an overload indicator lamp. This circuit eliminates the possibility of high duty cycle overload at fast repetition rate settings.

Pulse Forming Reset Circuit Description (Figure 3-1 a): Under normal conditions the differential amplifier (Q309, Q310) is biased so that Q310 has no collector current flowing and Q309 is accepting all the current from R328. This is due to the extra +0.7 volts bias on Q309's base because of the difference in voltage drop of CR313, CR314 versus CR319. When an output pulse is present, R336 adjusts the driver level to the base of Q310 so that it follows exactly the waveform from TP2 on the base of Q309.

If during the time the output pulse is on its amplitude drops, the bias difference between Q309 and Q310 will change causing Q310 to turn on and Q309 to turn off. This negative going waveform is coupled through C324, Q311 and Q312, and will cause the pulse forming flip-flop to return to its quiescent state. This then turns the main output off until the pulse forming flip-flop accepts another leading edge trigger.

Trigger Hold Off & Overload Lamp Indicator Circuit Description (Figure 3-1 b): Under normal conditions this circuitry is inoperative due to W"L" biasing off Q315 when the output is operating.

When the output drops below 40 volts W"L" returns to -40 volts causing Q315 to be biased on. The next trailing edge trigger which occurs will cause Q314 to conduct through Q315, forming W"AM". W"AM" triggers a one second multivibrator which supplies a gate for holding off all leading and trailing edge triggers and drives a front panel overload indicator lamp.

The one second multivibrator is actually two multivibrators in tandem, allowing for immediate reset in case of prolonged overloads.

NOTE: On narrow pulses, increasing the rise time of the output pulse will cause the output amplitude to drop triggering the overload protection circuit.

CAUTION

When observing or making any connections to the output circuitry including its power supply, it is necessary that the PULSE POLARITY switch be on OFF or NEG to avoid permanent damage to the unit.

3.2 CIRCUIT DESCRIPTIONS

3.2.1 Internal Oscillator (Refer to Figure 3.2)

The internal oscillator is an emitter coupled RC oscillator which functions as follows:

Assume Q2 has just begun to conduct, its collector dips negative. This signal on the base of Q3 drives its emitter negative. The negative signal at the emitter of Q3 is coupled across C_t to the emitter of Q2 causing conduction to increase. The increase of conduction through Q2 causes its collector to dip more negative, regeneratively driving Q2 toward saturation until the clamp voltage of the anode of CR1 is reached. C_t charges through Q2, R6 and R10. As C_t becomes charged to the signal voltage, its contribution to the current through R6 will

decrease. As the current through R6 decreases, the collector of Q2 moves positive. This positive going signal on the base of Q3 causes the emitter of Q3 to move positive and the positive going waveform is coupled across C_t to the emitter of Q2 decreasing conduction. As conduction of Q2 decreases its emitter becomes more positive regeneratively cutting off Q2. C_t now discharges through R_t and Q3. When C_t has discharged down to the level set at the base of Q2, Q2 will again begin to conduct and the cycle will be repeated. The negative spike at the collector of Q2 is emitter follower coupled to the Schmitt trigger circuit by Q4. Q1 provides a low impedance clamp voltage for CR1.

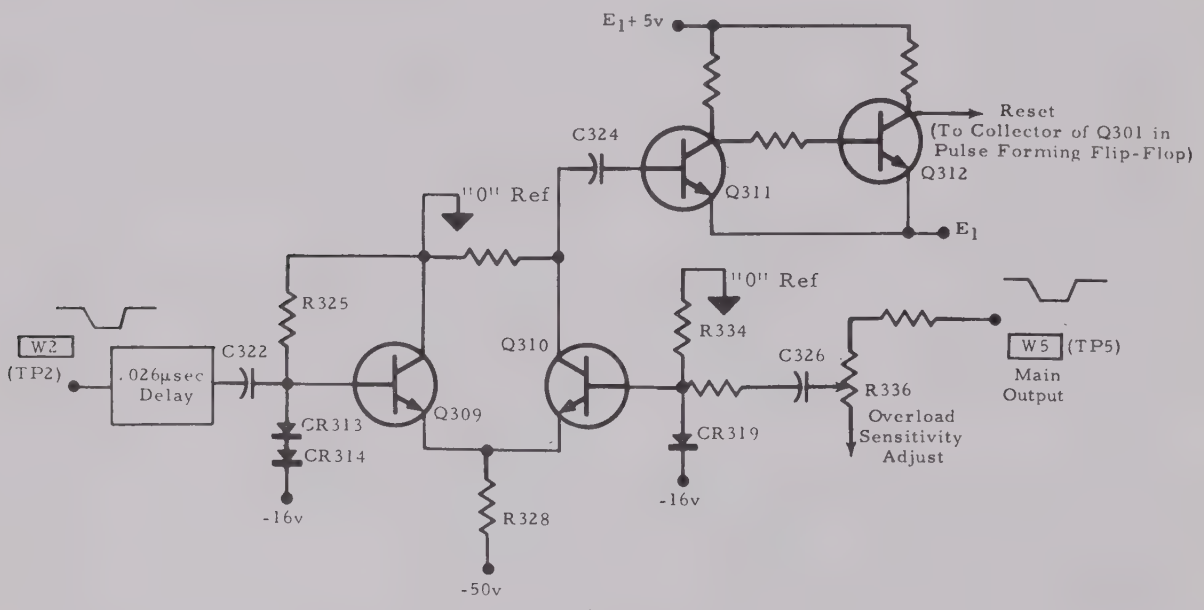


Figure 3-1 a. Simplified Schematic
Overload Protection - Pulse Forming Reset Circuitry

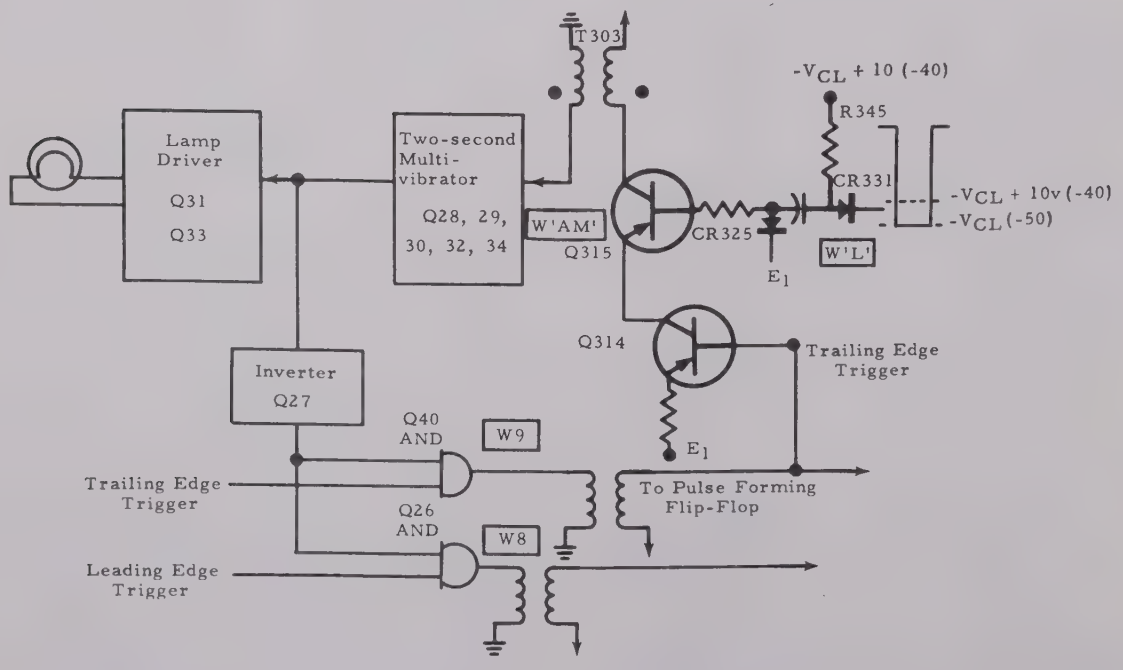


Figure 3-1 b. Simplified Schematic - Overload Protection

3.2.2 Schmitt Trigger Circuit

The Schmitt trigger circuit is used to standardize waveforms either from the internal oscillator or external triggers having varying waveshapes. Because of regeneration during switching, the output of the Schmitt circuit has relatively constant rise time regardless of input waveshape.

Initially, Q5 is conducting. Both the emitter of Q5 and the emitter of Q6 are approximately at the base potential of Q5 which is set by the voltage divider composed of R12, R13 and R14. The collector of Q5 is clamped by CR2 to another point on the divider. The base of Q6 is set by the divider consisting of R18 and R19 to a point more negative than its emitter. Therefore, Q6 is cut off.

When a negative going signal is applied to the base of Q5, conduction decreases and the collector of Q5 goes positive. This positive going waveform is coupled to the base of Q6 by R18 and C14 causing Q6 to conduct. The positive voltage at the emitters of Q5 and Q6 increases as the conduction of Q6 increases and causes the conduction of Q5 to decrease still more. The collector of Q5 becomes more positive, the conduction of Q6 increases and Q5 is regeneratively cut off.

The base of Q5 goes positive when the applied negative signal subsides and causes the collector of Q5 to go negative. This negative going signal is coupled to the base of Q6 causing its conduction to decrease. The emitters of Q5 and Q6 become less positive and the conduction of Q5 increases. This lowers the collector voltage of Q5 and causes the conduction of Q6 to decrease still more. Q6 is regeneratively cut off and the circuit returns to its static state.

Positive going inputs initiate switching at the base of Q6 and the rest of the cycle is similar to that for negative triggering.

Output of the circuit is taken from the collector of Q6.

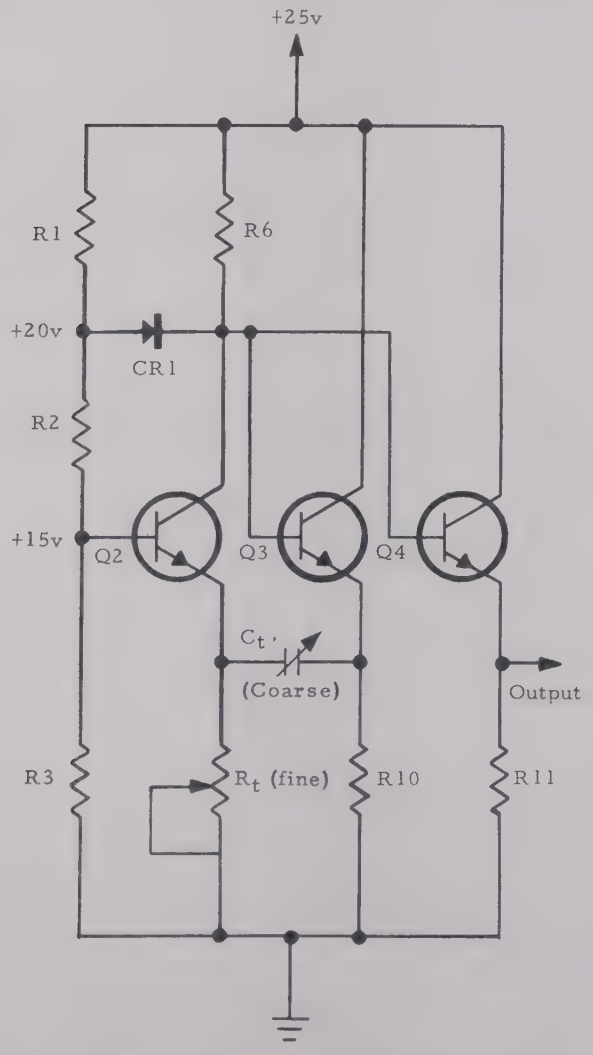


Figure 3-2. Simplified Internal Oscillator.

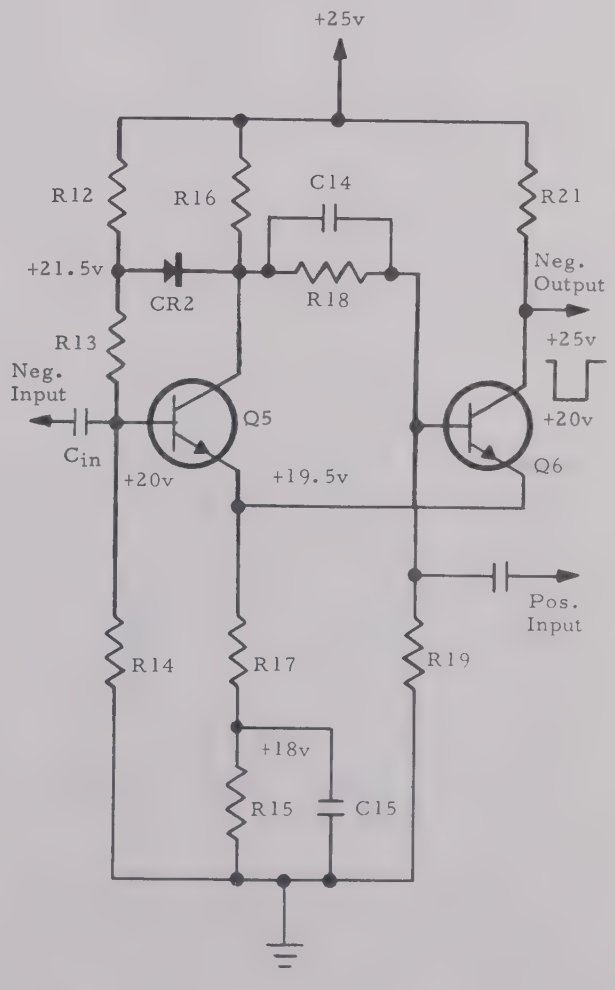


Figure 3-3. Simplified Schmitt Trigger.

3.2.3 One-Shot Multivibrator (Figure 3-4)

The pulse delay circuitry is an emitter coupled one-shot multivibrator. As pulse width is essentially a delay function (i.e., the delay of trailing edge with respect to leading edge), the same technique is used to perform both operations. The circuit functions as follows:

In the static state Q13 is held on by the bias developed across CR73 and CR75. The collector of Q13 is clamped at approximately -4 volts by CR74. Upon the application of a negative trigger at the base of Q13, Q13 is turned off and its collector rises toward +25 volts, but is clamped at ground by CR76. This positive step is emitter follower coupled to C_t by Q14, coupled across C_t and through emitter followers Q15 and Q16 back to the emitter of Q13. C_t now begins to charge through R_t, R76 and Q14. When C_t has charged to the signal voltage, Q13 again begins to conduct. The collector of Q13 drops back to the -4 volt clamp level and C_t discharges through R74, R76 and CR77.

Output is taken off the collector at Q13. This gate is delivered to the pickoff amplifier to obtain leading or trailing edge output pulse triggers.

3.2.4 Pickoff Amplifier (Figure 3-5)

The pickoff amplifier uses a non-inverting transformer (T81) to differentiate the gate produced by the delay and width one-shot multivibrators. Its operation is as follows:

Initially, steady state current flows in Q19 and the primary of T81. The base of Q20 is biased at -5 volts. As Q20 is an emitter follower, its emitter is at approximately -5 volts and holds Q21 cutoff. The collector of Q21 is clamped at ground by CR81.

At the initiation of the input gate, the base of Q19 is driven positive increasing conduction. This causes the collector to dip negative as a magnetic field is built up in T81. The negative going signal is applied to the base of Q20 and then to the base of Q21. As Q21 is already cut off no change takes place in its collector circuit. The magnetic field in T81 is soon built up and the negative pulse subsides.

At the termination of the input gate, the negative going trailing edge causes current in Q19 to decrease and the field in T81 collapses causing a positive spike at the base of Q20. This positive spike is coupled to the base of Q21. Q21 then conducts driving its collector sharply negative, producing a negative delayed trigger.

3.2.5 Output Amplifier and Pulse Forming Circuitry (Refer to Schematic 40000-056)

The output amplifier driving pulse is formed through the use of a bistable multivibrator which is triggered by the leading and trailing edge triggers from the pulse width and delay one-shot multivibrators. The pulse from the bistable circuit is formed by the rise and fall time circuit and is amplified by several stages of emitter followers to raise the power level of the pulse.

The output transistors are in a common base configuration and would be driven slightly into saturation except for the use of clamp diodes which limit the collector-to-base voltage to approximately 4 volts. If the clamp diodes were not used, storage effects caused by the relatively high T_s in the output transistors would distort the output pulse considerably.

In the static state the emitter of Q1 is more positive than $-V_b$ by the drop across CR1 and V_{be} of Q1. This places the emitter of Q2 more positive than its base and therefore in a cutoff condition. Upon the application of a negative signal to the base of Q1, the base emitter diode of Q2 is forward biased, and a current of magnitude $\frac{\text{E signal}}{\text{R emitter}}$ flows in the emitter of Q2. A current of Alpha (approximately 0.95 to 0.98) times the emitter current flows in the collector of Q2 and through the load R_L. As the negative input pulse subsides the circuit reverts to the static state. The clamp voltage ($-V_{c1}$) limits the amplitude of the output pulse and is varied approximately 20 percent to provide the continuous fill-in between the constant impedance attenuator voltage settings.

3.2.6 Transition Time Control Circuit (Figure 3-7)

Transition time control is accomplished through the use of an integrating amplifier.

The operation of the amplifier (Q305-Q306) is to hold the base of Q305 at a near constant potential by negative feedback through C_t from the collector of Q306, thus drawing i_1 through C_t.

$$i_1 = \frac{E_2 - V_b\ (Q305)}{R314} \cong \frac{E_2 - E_3}{R314}$$

The circuit will operate with current flowing in either direction through R314 and for the sake of simplicity the difference between E_1 (or E_2) and the reference level (E_3) will be referred to as e in.

When current (i_1) flows in a condenser (C_t) the potential across it (e out) is:

$$\frac{1}{C_t} \int i_1\, dt$$

assuming i_1 constant this becomes

$$\text{e out} = \frac{i_1\ t}{C_t}$$

but $$i_1 = \frac{\text{e in}}{R314}$$

therefore $$\text{e out} = \frac{(\text{e in})\ t}{(R314)\ C_t}$$

Assuming e out has a swing of 5 volts (controlled by the emitter voltage on Q306 and the clamping action of CR311 to -10 volts) the rise or fall time (t) will be:

$$t = \frac{(5V)\ (R314)\ (C_t)}{\text{e in}} = \frac{(5V)\ (2.7k)\ (C_t)}{\text{e in}}$$

thus the rise and fall time at the collector of Q306 is a function of e in and C_t.

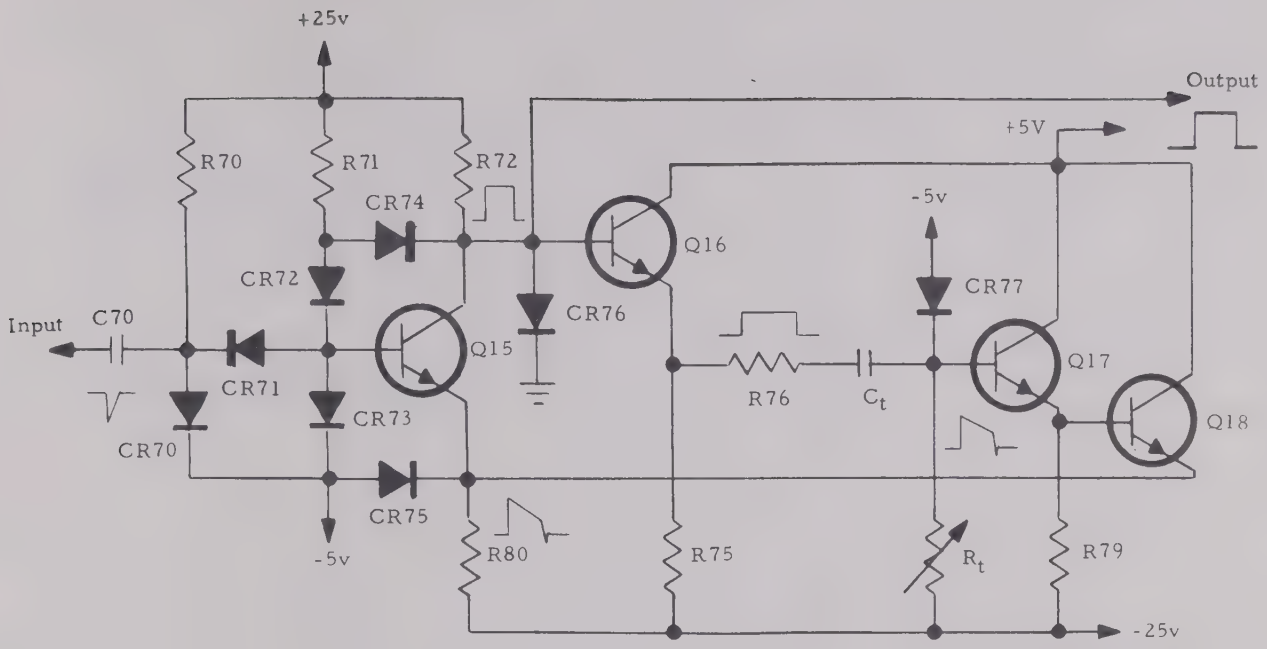


Figure 3-4. Simplified One-Shot Multivibrator.

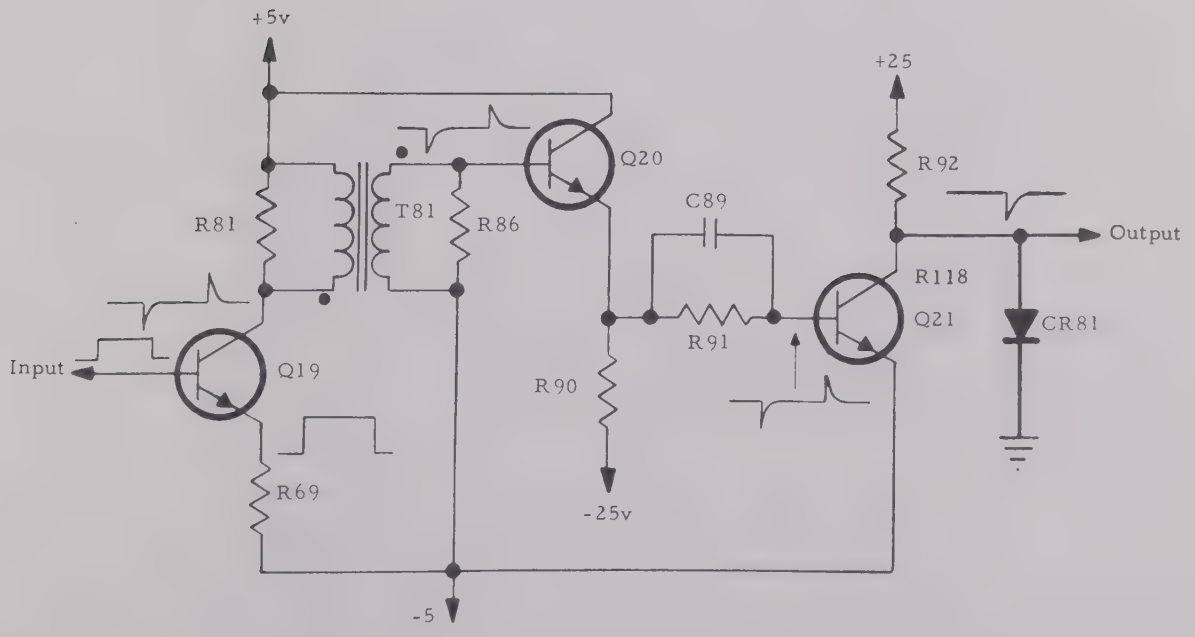


Figure 3-5. Pickoff Amplifier.

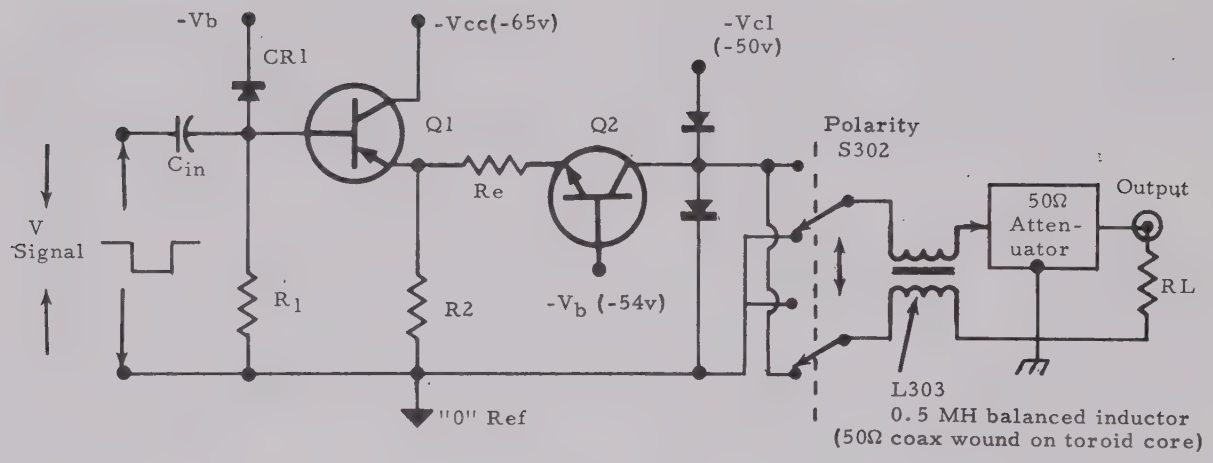


Figure 3-6. Simplified Output Circuit.

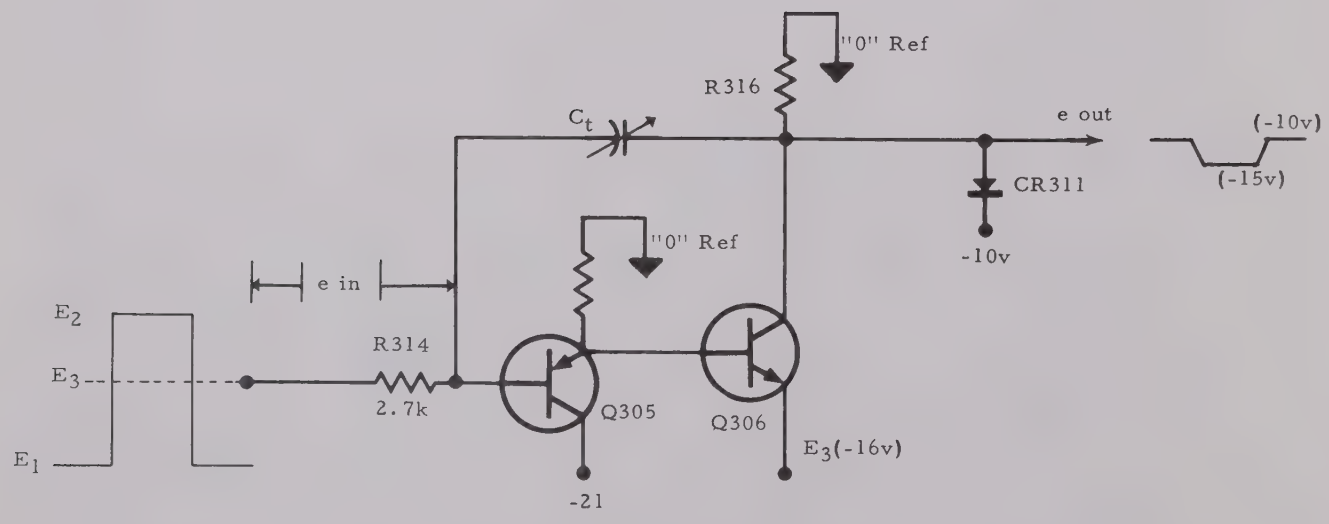


Figure 3-7. Simplified Transition Time Control Circuit.

The TRANSITION TIME RANGE switch selects values of C_t for coarse control while the input voltage levels E_2 and E_1 are varied above or below E_3 for leading edge and trailing edge vernier.

3.2.7 Reversing Pulse Polarity (Figure 3-6)

Pulse polarity is reversed by merely reversing the connections between the center conductor and shield of the coaxial cable carrying the pulse. Polarity switch S390 performs this function. This method of reversing polarity is possible because a floating power supply is used allowing the ground reference to be established at any level. Negative pulse outputs occur when the collectors of the output transistors drive the center conductor of the 50 ohm coaxial and the 0 volt reference is tied to the shield. Positive cable pulses occur by reversing these connections and placing the 0 volt reference in the center conductor. The capacity of the 0 volt reference to the instrument chassis would load the positive polarity pulse were it not for the balun choke (L303) effectively isolating this capacity from the chassis The 0 volt reference capacity to the chassis is kept at a minimum through the use of a low capacity power transformer and careful circuit layout.

CAUTION

When observing, or making any connections to the output circuitry, including its power supply, it is necessary that the PULSE POLARITY switch be on OFF or NEG to avoid permanent damage to the unit.

SECTION IV
MAINTENANCE INSTRUCTIONS

4.1 PREVENTIVE MAINTENANCE

4.1.1 Preventive Inspection and Service

Inspection and service of a preventive nature will result in optimum performance and longer life of this instrument. Dust covers should be removed at regularly scheduled intervals to permit inspection for dust, tarnish, corrosion, loose nuts and bolts (especially those serving as electrical conductors), loose cables and fuses, charred insulation, scorched resistors and broken wiring. Discoloration of the printed circuit board due to heat does not affect the board's electrical properties and may be disregarded in most cases.

4.1.2 Minor Repairs

The operator should be thoroughly acquainted with the instrument's circuit theory and component location before attempting repair. In all cases, setting and adjustment of controls should be checked in order to verify that difficulties encountered are actually caused by malfunction and not by operation outside of specifications. Check transistors in suspected circuits prior to conducting extensive tests on other components.

4.1.3 Recalibration

This instrument was designed to provide maximum reliability and stability. To insure that accuracy remains within stated limits, we suggest that calibration be checked after every 200 hours of operation. See Section 4.5 for calibration check. If the unit is used intermittently, calibration should be checked every three months.

4.2 PARTS REMOVAL AND REPLACEMENT

4.2.1 General

This instrument is sturdily built and components easily accessible. Removal of most parts is so simple that explanations are unnecessary. However, some parts are more easily removed if a definite procedure is followed. Replacement of some parts will also require partial recalibration. Refer to Section 4.4 for calibration instructions.

4.2.2 Removal of Dust Covers

The dust covers are held in place by small screw-head fasteners. To remove, turn the fasteners a quarter turn counterclockwise with a common screwdriver. To remove the top dust cover: (1) remove the four fasteners on the sides of the top dust cover; (2) loosen the two fasteners on the top of the dust cover; and (3) lift the cover up and off.

To remove the bottom dust cover: (1) turn the instrument upside down; (2) loosen the four fasteners on the bottom of the cover; and (3) lift the cover up and off.

4.2.3 Replacement of Power Transistors

The power transistors which are mounted to the rear panel must have a thin film of silicon grease (such as Dow Corning DC-4) applied to the common surfaces between the transistor, the mica washer and the panel.

4.2.4 Soldering Considerations

Although printed wiring is quite vulnerable to heat excesses, a great deal of resoldering can be done on a single joint if care is taken. A 35 watt wedge tip or pointed tip iron and 60-40 rosin core solder are quite effective. Where both sides of the board are accessible apply the tip of the iron (on the side opposite the component) directly to the solder fillet and pull gently on the pigtail with pliers from the opposite side. Where both sides of the circuit board are not accessible, the component lead will be fed through the board through an eyelet. Apply the iron tip to the eyelet and pull the pigtail out with the pliers. To insert a new component, clean out the hole with a sharp object (it may be necessary to apply more heat) and insert the new component, soldering in the old place.

4.3 TROUBLESHOOTING PROCEDURE

Before any troubleshooting is attempted, the front panel controls should be checked for proper setting. You may wish to refer to Paragraph 2.3, Operating Considerations, which details many of the limitations of the instrument and describes the performance to be expected. After you have ascertained that trouble does exist, you may continue according to the procedures outlined in this section.

Many apparent malfunctions are due to improper calibration of one or more of the circuits, and often a transistor is replaced that requires recalibration. If you suspect that a circuit is miscalibrated, refer to Section 4.5 which describes a procedure for determining calibration status. Section 4.4 provides a detailed calibration procedure.

Whenever trouble occurs, check the power supply voltages. This test may be done by following Paragraph 4.4.3 of the calibration procedure. It may be assumed that the power supplies are functioning properly if the output and ripple voltages are correct.

When malfunction can be attributed to a particular circuit, perform a complete visual inspection in that area. See Figure 4-1 for the location of circuits. Frequently visual inspection reveals the effects of the trouble (such as burned resistors) rather than the cause. However, these effects may give clues as to the actual cause.

4.3.1 Troubleshooting the Power Supplies

Almost all power supply failure may be typified by collector to emitter shorts (transistors) and anode to cathode shorts (rectifiers and zener diodes). These conditions are easily detected in circuit with an ohmmeter because they measure very low resistance in both directions.

4.3.2 Troubleshooting the Pulse Circuits

Once it has been ascertained that the power supplies are functioning correctly, the most straightforward method of tracking down trouble is to begin at TP1 and proceed through the instrument comparing waveforms to those listed in the schematic. This will generally narrow the trouble down to one of a very few components. Because of the straight-through nature of the instrument circuitry, most troubles will manifest themselves as complete absence of output pulses or invariability of one or more of the pulse parameters. In the latter case, a good indication is given as to which circuit to suspect.

4.4 CALIBRATION PROCEDURE

4.4.1 General

Remove dust covers and connect instrument and ac voltmeter to auto transformer. Set to 115 volts ac (230 volts if so wired) and energize instrument. Allow five minutes warmup before commencing calibration. During this period make sure that the instrument is working properly. If any portion of the instrument fails to calibrate, repair should be effected before attempting to complete calibration.

4.4.2 Equipment Required

a. An rms reading ac voltmeter with 0-150 volt range (0-300 volt range if wired for 230 volt operation).

b. A variable line auto transformer such as Powerstat Series 20.

c. A multimeter with an accuracy of at least 3% and a sensitivity of 20,000 ohms per volt; Triplett Model 630 or equivalent.

d. A general purpose oscilloscope of at least 30 mc bandpass with either delayed sweep or high sweep magnification; Model HP 175A or Tektronix Type 543 is adequate.

e. A wide band oscilloscope such as HP Model 185B or Tektronix Type 661 is necessary for fine adjustment of output waveform.

f. A 50 ohm, 1%, 25 watt termination; Datapulse Type 2003.

g. An insulated, low-capacity screwdriver.

h. Optional: A 10 mc counter; HP Model 5243 or equivalent.

4.4.3 Power Supply Calibration

Because the timing circuits are dependent upon the regulated power supply voltages for reference, any variances of these voltages will necessarily cause a change in calibration accuracy. Therefore, these adjustments should not be attempted unless one is prepared to carry out complete recalibration.

Due to internal referencing within the power supply, the following adjustment sequence must be followed: (front end power supply voltages are measured with respect to GRD and output power supply voltages are measured with respect to 0 REF).

Refer to Figures 4-1, 4-2 and 4-3 for adjustment and test point locations.

a. Connect a dc voltmeter from +25V test point to ground. Set R516 (+25V ADJUST) for a reading of 25 volts. Vary line voltage ±10% around 115 volts and verify regulation.

b. Connect dc voltmeter from +5V point to ground. Set R522 (+5V ADJUST) for a reading of 5 volts.

c. Connect dc voltmeter from -25V test point to ground. Set R536 (-25V ADJUST) for a reading of 25 volts. Vary line voltage ±10% around 115 volts and verify regulation.

d. Connect dc voltmeter from -5V point to ground. Set R539 (-5V ADJUST) for a reading of 5 volts.

e. Check ripple on all supplies. Ripple should be less than 30 millivolts peak to peak.

f. Connect dc voltmeter from $-V_{cc}$ to 0 REF. Set amplitude vernier (located on front panel) fully clockwise. Set R408 (MAX AMPL) for a reading of 65 volts. Vary line voltage ±10% around 115 volts and verify regulation.

g. Connect dc voltmeter from $-V_{c1}$ to 0 REF and verify a reading of 50 volts.

h. Connect dc voltmeter from -50V to 0 REF. Set R423 (-50V ADJUST) for a reading of 50 volts.

i. Connect dc voltmeter from E_3 to 0 REF. Set R450 (OUTPUT DRIVE ADJUST) for a reading of -16 volts.

j. Turn TRANSITION TIME LEADING EDGE and TRAILING EDGE controls located on front panel, fully counterclockwise.

k. Connect dc voltmeter from E_1 to 0 REF and verify a reading of approximately -21 volts.

l. Connect dc voltmeter from E_2 to 0 REF and verify a reading of approximately -11 volts.

m. Connect dc voltmeter from E_1 +5V to 0 REF and verify a reading of a approximately -16 volts.

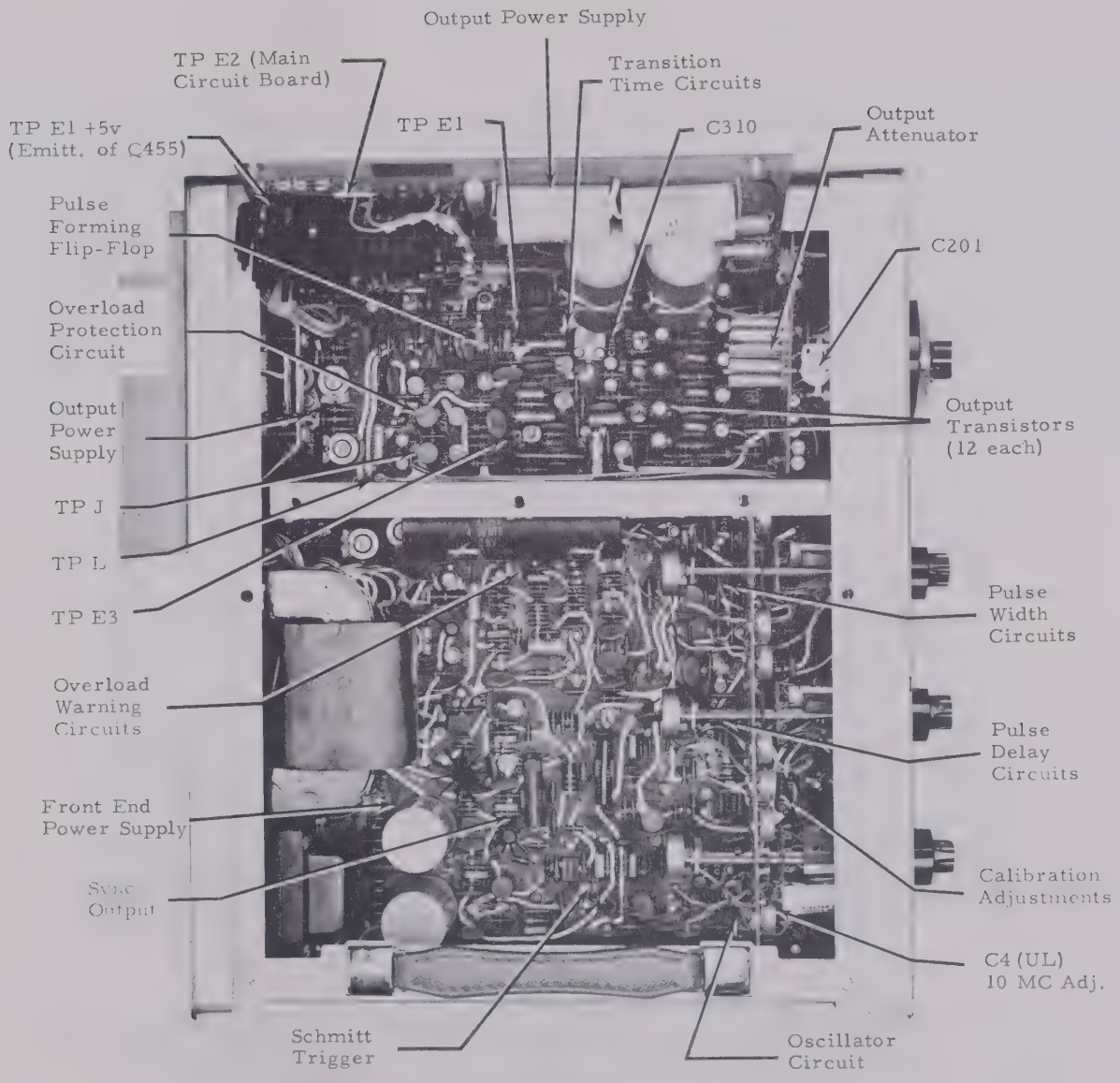


Figure 4-1. Top View, Model 108L. Circuit, Test Point and Adjustment Location

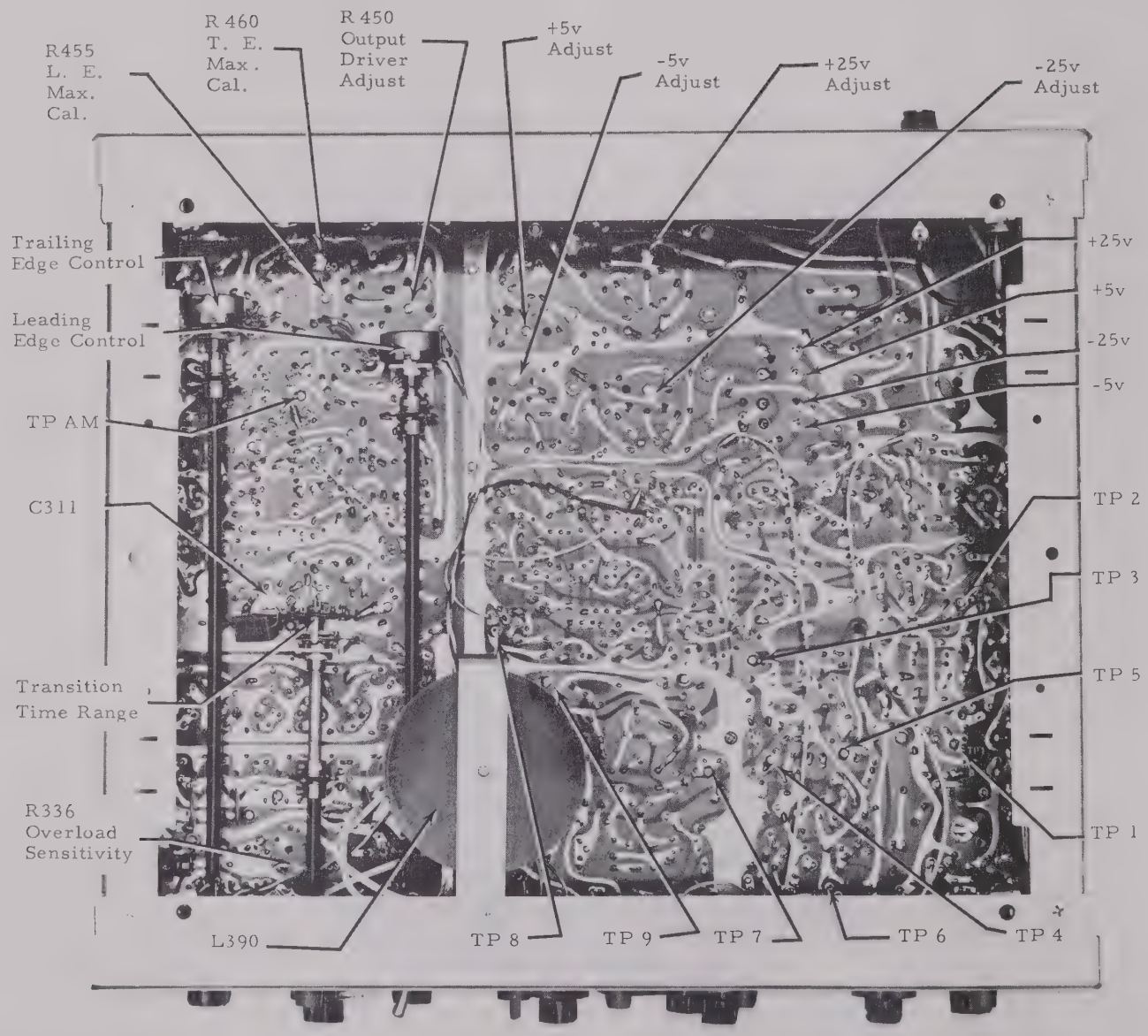


Figure 4-2. Bottom View, Model 108L. Adjustment and Test Point Location

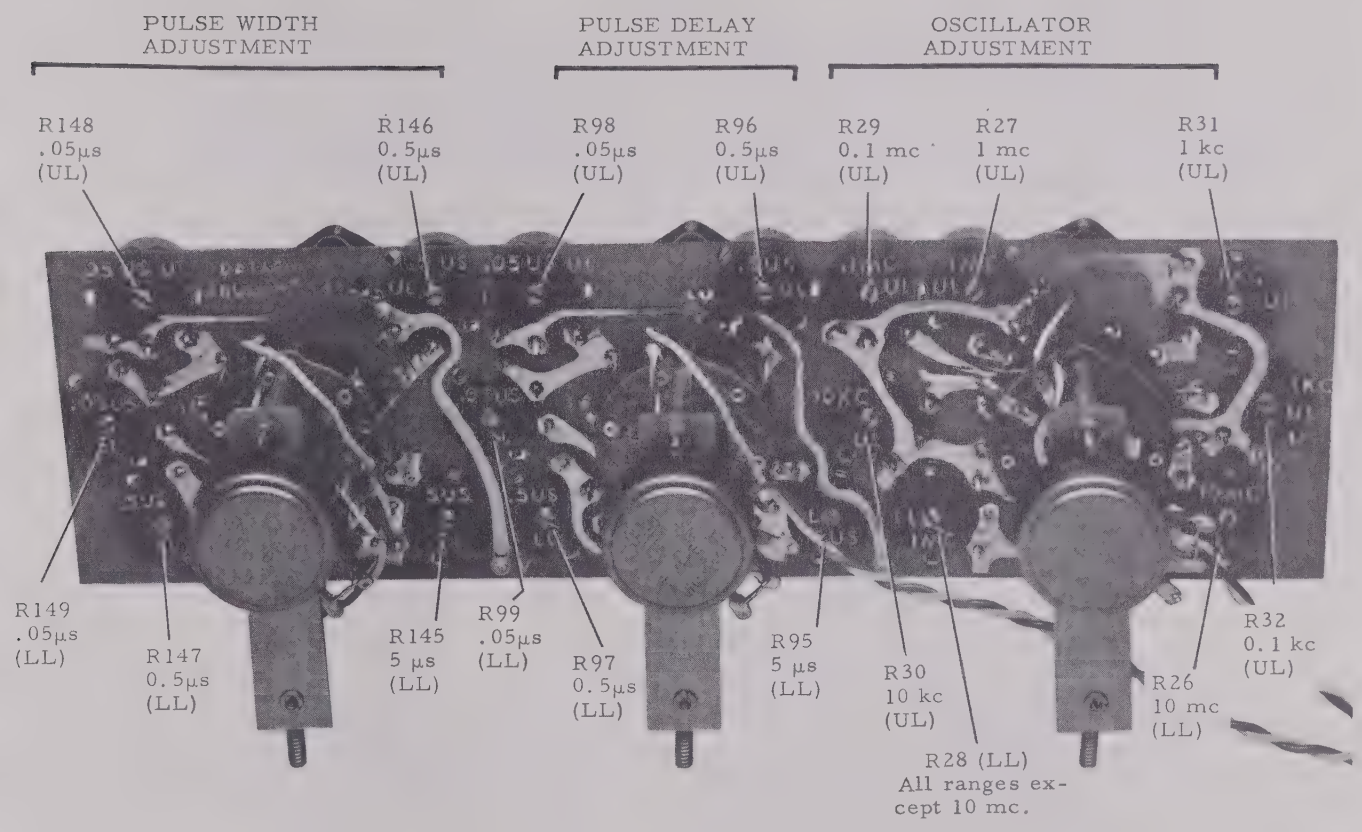


Figure 4-3a. Calibration Adjustments

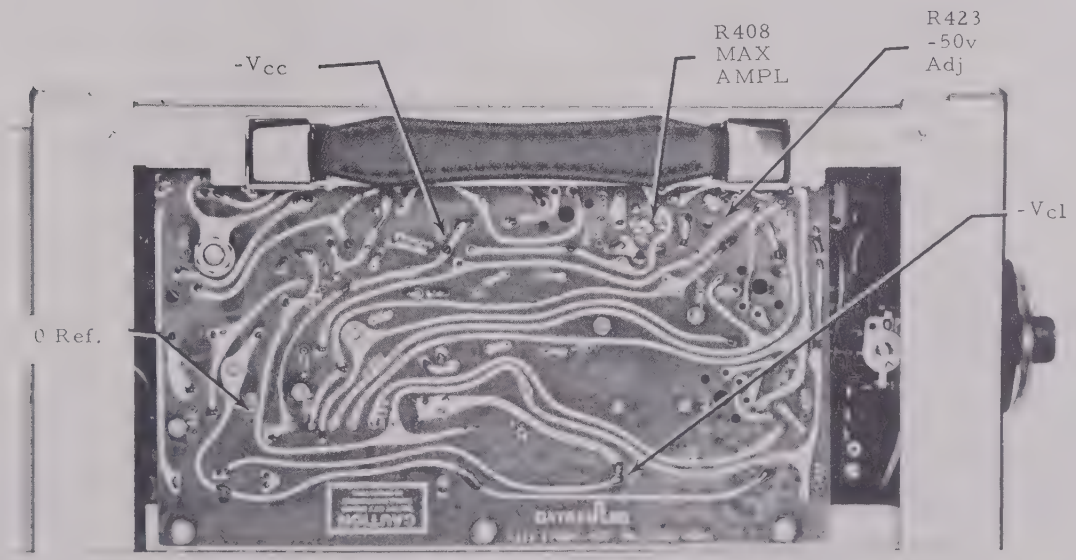


Figure 4-3b. Output Power Supply. Adjustment and Test Point Locations

4.4.4 Repetition Rate Calibration

NOTE: Because calibration accuracy of most oscilloscopes is in the range of ±5%, the ultimate calibration accuracy of the instrument is limited by this value, i.e., if the instrument is calibrated using an oscilloscope which is 5% off in one direction and is then checked with another which is 5% off in the opposite direction, a 10% deviation will be shown. If calibration is performed using a frequency meter type of counter, such as HP Model 5243, driving the counter with the positive sync pulse output, calibration accuracies of 1% or better can usually be obtained. However, one must bear in mind that if the output is then viewed on a 5% oscilloscope, this accuracy may appear as 6%. The following procedure is given for calibration of repetition rate using a counter.

a. Set PULSE DELAY and PULSE WIDTH controls to 0.05 MICROSEC with vernier fully counterclockwise.

b. Adjust oscillator according to Table 4-1. The deviation on the lower limit (LL) adjustment is to provide a small measure of overlap of ranges and assure continuous coverage of all frequencies. The reason for adjusting the upper limit (UL) first is that the upper limit adjustment affects both ends of the range and is independent of the lower limit setting. When using the oscilloscope for calibration, view the positive pulse output terminated into 50 ohms with a minimum rise and fall time. Widen pulse as necessary for oscilloscope presentation.

NOTE: It may be necessary to compromise setting of R28 (lower limit) so that the lower limit at the 1 mc through 0.1 kc ranges is within specification, i.e., less than the stated values.

4.4.5 Pulse Delay Calibration

Delay is measured from the 50% point on the leading edge of the positive sync output pulse to the 50% point on the main pulse output. Pulse delay accuracy is defined for minimum output pulse rise time.

NOTE: For calibration of pulse delay, a dual trace oscilloscope is convenient but not mandatory. To use a single channel oscilloscope, first view the positive sync output and align the 50% point of the leading edge with the left hand edge of the graticule by using thehorizontal position control. Next, view the main pulse output and make delay measurement using the left hand edge of the graticule as a reference. It will be necessary to realign the oscilloscope after every change of sweep speed. For dual trace oscilloscope, view sync on one trace and the output pulse on the other.

a. Pulse spacing (inversely proportional to repetition rate) must be kept at least ten times the delay setting. Set PULSE WIDTH to 0.5 MICROSEC.

b. Adjust delay according to Table 4-2. The long upper limit calibration points are to insure overlap at ranges giving continuous coverage.

NOTE: It may be necessary to compromise the adjustment of R95 (5 μs LL) such that the lower limit of the 0.05 ms and 0.5 ms ranges is within specifications or to compromise the adjustment of R96 (0.5 μs UL) such that the upper limit of 5 μs, 0.05 ms, and 0.5 ms ranges is within specifications.

4.4.6 Pulse Width Calibration

Pulse width is measured from the 50% point on the leading edge to the corresponding point on the trailing edge. Pulse width calibration accuracy is defined for minimum output pulse rise and fall time.

a. Set PULSE DELAY to 0.05 MICROSEC, vernier counterclockwise. Pulse spacing (inversely proportional to repetition rate) must be kept at 10 times the pulse width during calibration.

b. Adjust PULSE WIDTH according to Table 4-3. The wide upper limit calibration points assure that the ranges overlap to provide continuous coverage.

NOTE: It may be necessary to compromise the adjustment of R145 (5 μs LL) such that the lower limit of the 0.05 ms and 0.5 ms ranges is within specification or to compromise the adjustment of R146 (0.5 μs UL) such that the upper limit of the 5 μs, 0.05 ms and 0.5 ms ranges is within specification.

4.4.7 Output Circuit Calibration

NOTE: For optimum performance, calibration of the output circuits requires the use of a high bandpass oscilloscope such as the HP Model 185B.

CAUTION

When making any connections to the output circuitry, including its power supply, it is necessary that the PULSE POLARITY switch be on OFF or NEG to avoid permanent damage to the unit.

a. Set REPETITION RATE to 0.1 MC/S.

b. Set PULSE DELAY to 0.1 MICROSEC.

c. Set PULSE WIDTH to 0.5 MICROSEC.

d. Sync oscilloscope from sync output. Set sweep speed to 0.1 μsec/cm and view the negative output pulse terminated into 50 ohms.

e. Adjust R450 (OUTPUT DRIVE ADJUST) counterclockwise until it is apparent that the pulse top drops just below the clamp level. Back the control off until the pulse top is slightly past clamp. See Figure 4-4.

TABLE 4-1.

REPETITION RATE ADJUSTMENT

Rep Rate Range	Vernier Position (R36)	Adjust.	Counter Reading*	Scope Pulse Spacing*
10 mc	cw	C4 (UL)	$\geq$ 10 mc	$\leq$ 0.1 μs
10 mc	ccw	R26 (LL)	< 1 mc	> 1 μs
1 mc	cw	R27 (UL)	$\geq$ 1 mc	$\leq$ 1 μs
1 mc	ccw	R28 (LL)	< 100 kc	> 10 μs
0.1 mc	cw	R29 (UL)	$\geq$ 100 kc	$\leq$ 10 μs
0.1 mc	ccw	See Note	< 10 kc	> 100 μs
10 kc	cw	R30 (UL)	$\geq$ 10 kc	$\leq$ 100 μs
10 kc	ccw	See Note	< 1.0 kc	> 1 ms
1 kc	cw	R31 (UL)	$\geq$ 1 kc	$\leq$ 1 ms
1 kc	ccw	See Note	< 100 cps	> 10 ms
0.1 kc	cw	R32 (UL)	$\geq$ 100 cps	$\leq$ 10 ms
0.1 kc	ccw	See Note	< 10 cps	> 100 ms

* Adjustment tolerances are +5%, -0% for $\geq$ and +0%, -5% for $\leq$ on upper limit (cw) settings. Lower limit (ccw) settings should provide adequate overlap to meet specifications.

TABLE 4-2.

DELAY CALIBRATION ADJUSTMENT

Delay Range	Vernier Position (R100)	Adjust.	Delay Setting*	Scope Sweep Speed (per cm)	Rep Rate
0.05 μs	ccw	R99 (LL)	0	20 ns	0.1 mc
0.05 μs	cw	R98 (UL)	$\geq$ 0.52 μs	0.1 μs	0.1 mc
0.5 μs	ccw	R97 (LL)	$\geq$ 0.5 μs	0.1 μs	10 kc
0.5 μs	cw	R96 (UL)	$\geq$ 5.2 μs	0.5 μs	10 kc
5 μs	ccw	R95 (LL)	$\geq$ 5 μs	0.5 μs	1 kc
5 μs	cw	See Note	$\geq$ 50 μs	5 μs	1 kc
0.05 ms	ccw	See Note	$\geq$ 50 μs	5 μs	0.1 kc
0.05 ms	cw	See Note	$\geq$ 0.5 ms	50 μs	0.1 kc
0.5 ms	ccw	See Note	$\geq$ 0.5 ms	50 μs	0.1 kc
0.5 ms	cw	See Note	$\geq$ 5 ms	0.5 ms	10 cps

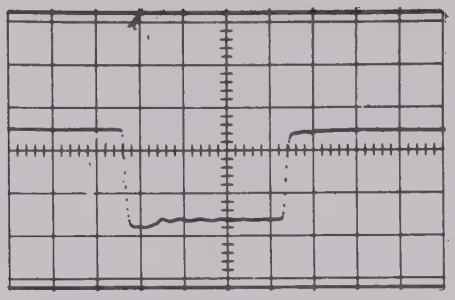
* Adjustment tolerances are +5%, -0% for $\geq$ and +0%, -5% for $\leq$.

TABLE 4-3.

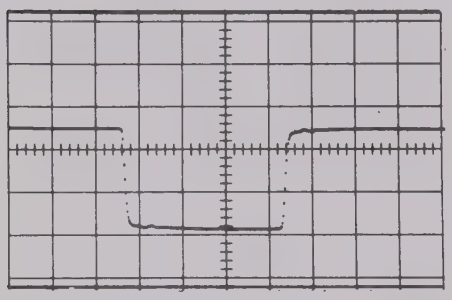
WIDTH CALIBRATION ADJUSTMENT

Width Range	Vernier Position (R150)	Adjust.	Width Setting*	Scope Sweep Speed (per cm)	Rep Rate
0.05 μs	ccw	R149 (LL)	Min.	20 ns	0.1 mc
0.05 μs	cw	R148 (UL)	$\geq$ 0.52 μs	0.1 μs	0.1 mc
0.5 μs	ccw	R147 (LL)	$\geq$ 0.5 μs	0.1 μs	10 kc
0.5 μs	cw	R146 (UL)	$\geq$ 5.2 μs	0.5 μs	10 kc
5 μs	ccw	R145 (LL)	$\geq$ 5 μs	0.5 μs	1 kc
5 μs	cw	See Note	$\geq$ 50 μs	5 μs	1 kc
0.05 ms	ccw	See Note	$\geq$ 50 μs	5 μs	0.1 kc
0.05 ms	cw	See Note	$\geq$ 0.5 ms	50 μs	0.1 kc
0.5 ms	ccw	See Note	$\geq$ 0.5	50 μs	0.1 kc
0.5 ms	cw	See Note	$\geq$ 5 ms	0.5 ms	10 cps

* Adjustment tolerances are +5%, -0% for $\geq$ and +0%, -5% for $\leq$.



a. Pulse Top Below Clamp Level, Turn R450 Counterclockwise to Obtain b.



b. Proper Pulse Top Adjustment.

Figure 4-4. Output Circuit Calibration.

4.4.8 Transition Time Calibration

a. Set REPETITION RATE to 10 KC/S.

b. Set PULSE DELAY to 0.

c. Set PULSE WIDTH to 5 MICROSEC, vernier counterclockwise.

d. Set PULSE POLARITY to POS.

e. Set AMPLITUDE at 5.0 volts, vernier clockwise.

f. Set TRANSITION TIME RANGE switch to 0.5-2.5 MICROSEC position

g. Set LEADING EDGE vernier for maximum (clockwise) and TRAILING EDGE vernier for minimum (counterclockwise).

h. View pulse output on general purpose, dc oscilloscope with calibrated sweep.

i. Adjust R455 (L.E. MAX. CAL.) for a rise time (from 10% point to 90% point) on the output pulse of approximately 2.8 μsec. This allows for some overlap between ranges.

j. Set LEADING EDGE vernier for minimum (counterclockwise) and TRAILING EDGE vernier for maximum (clockwise).

k. Adjust R460 (T.E. MAX. CAL.) for a fall time (from 10% point to 90% point) of approximately 2.8 microseconds.

This completes calibration adjustment procedure for the Datapulse Model 108L Pulse Generator.

4.5 SPECIFICATIONS VERIFICATION

A test similar to the following was performed on this instrument just prior to shipment to confirm published specifications. Before the test was conducted, the instrument was aged for a 24-hour period, and had undergone rigid examination for workmanship and appearance.

This test should be performed after every 200 hours of operation to confirm calibration status. Recalibrate and/or troubleshoot the instrument if the specifications are not verifiable.

4.5.1 Equipment Required

a. A general purpose oscilloscope of at least 30 mc bandpass with either delayed sweep or high sweep magnification. HP Model 175A or Tektronix Type 543 is adequate.

b. Oscilloscope, HP Model 185B, Tektronix Type 661, or equivalent (high bandpass).

c. 50 ohm termination, Datapulse 2003.

d. 30 dB coaxial attenuator, greater than 300 mc bandpass.

e. Trigger generator (10 mc).

f. Variable line auto transformer such as Powerstat Series 20.

4.5.2 Repetition Rate

Oscillator Timing:

a. Set PULSE DELAY to .05 MICROSEC, vernier counterclockwise.

b. Set PULSE WIDTH to 0.05 MICROSEC, vernier clockwise.

c. Set TRANSITION TIME for both leading and trailing edge to minimum.

d. Set AMPLITUDE to 50 volts, vernier clockwise.

e. Terminate output into 50 ohm load.

f. Sync oscilloscope from sync output.

g. View negative output pulse with general purpose oscilloscope and follow the panel control settings in Table 4-4.

TABLE 4-4.

REPETITION RATE CALIBRATION VERIFICATION

Rep. Rate	Vernier Position	Pulse Width	Sweep Speed (per cm)	Pulse Spacing	Tolerance
0.1 kc	ccw	5 ms	100 ms	100 ms (10cps)	
0.1 kc	cw	0.5 ms	10 ms	10 ms (0.1 kc)	±5% *
1 kc	ccw	0.5 ms	10 ms	10 ms (0.1 kc)	
1 kc	cw	50 μs	1 ms	1 ms (1 kc)	±5%
10 kc	ccw	50 μs	1 ms	1 ms (1 kc)	
10 kc	cw	5 μs	100 μs	0.1 ms (10 kc)	±5%
0.1 mc	ccw	5 μs	100 μs	0.1 ms (10 kc)	
0.1 mc	cw	0.5 μs	10 μs	10 μs (0.1 ms)	±5%
1 mc	ccw	0.5 μs	10 μs	10 μs (0.1 ms)	
1 mc	cw	50 ns	1 μs	1 μs (1 mc)	±5%
10 mc	ccw	50 ns	1 μs	1 μs (1 mc)	±5%
10 mc	cw	50 ns	0.1 μs	0.1 μs (10 mc)	±5%

* See NOTE at beginning of Step 4.4.4.

Jitter:

a. Set controls as per steps a through f of preceding paragraph (Oscillator Timing).

b. Set REPETITION RATE to 10 MC/S, vernier fully clockwise.

c. Set sweep speed to 0.1 μS/cm.

d. View positive output pulse terminated into a 50 ohm load. One pulse should appear for each cm. View the tenth pulse and expand sweep to 10 ns/cm. The jitter should be less than 0.1 cm, (0.1%).

Stability: Leave setup as in preceding paragraph. Vary input voltage from 105 volts ac to 125 volts ac. The shift should be less than 2 cm (2%).

External Triggering: Apply a ±5 volt signal from trigger generator to the external trigger input jack and verify that instrument can be slaved up to 10 mc with repetition rate control in both EXT (+) and EXT(-) positions.

Sync Pulse:

a. Set DELAY and WIDTH to minimum.

b. Set SYNC POLARITY to POS.

c. Set SYNC VOLTS INTO 50Ω knob clockwise.

d. View sync pulse output into 50 ohm load (Datapulse 2002 or equivalent).

e. Sync pulse amplitude should not drop below 6 volts when REPETITION RATE is varied from 1 mc to 10 mc.

f. Set SYNC POLARITY to NEG.

g. Verify sync pulse amplitude of 6 volts or more.

h. Set SYNC VOLTS INTO 50Ω knob counterclockwise.

i. Verify sync pulse amplitude of approximately 0.25 volts.

External Gate Input:

a. View output pulse.

b. Verify that the output pulse does not occur when a -6 volt dc signal is applied to the GATE INPUT connector.

4.5.3 Pulse Delay

Delay Timing:

a. Set pulse AMPLITUDE to 10 volts with vernier to X1.

b. Set TRANSITION TIME for both leading and trailing edges to minimum.

c. Set REPETITION RATE to 0.1 MC/S, vernier clockwise.

d. Sync oscilloscope from sync output.

e. Monitor the sync output and positive pulse output simultaneously and follow the control settings of Table 4-5.

Delay Duty Cycle:

a. Set REPETITION RATE to 0.1 MC/S, vernier clockwise.

b. Set PULSE WIDTH to 0.05 microsecond, vernier clockwise.

c. Sync oscilloscope from positive sync output with sweep speed of 1 microsecond/cm.

d. View positive pulse output (50 ohm termination).

e. Set PULSE DELAY to 0.5 microsecond, vernier counterclockwise. Slowly turn vernier clockwise and verify that 50% delay duty cycle (5 microseconds) can be attained without circuit failure.

Delay Jitter:

a. With controls set as in preceding paragraph (5 microseconds delay), set sweep speed to 0.5 microsecond/cm. and expand to 50 nanoseconds/cm.

b. View leading edge of pulse and verify that jitter is less than 0.1 cm (0.1%).

TABLE 4-5.

DELAY CALIBRATION VERIFICATION

Delay Range	Vernier Position	Pulse Width	Rep Rate	Sweep Speed (per cm)	Delay	Tolerance
0.05 μs	ccw	50 ns	0.1 mc	20 ns	0 ns	approx.
0.05 μs	cw	50 ns	0.1 mc	50 ns	0.5 μs (10 cm)	±0.5 cm
0.5 μs	ccw	0.5 μs	10 kc	50 ns	0.5 μs (10 cm)	±0.5 cm
0.5 μs	cw	0.5 μs	10 kc	0.5μs	5 μs (10 cm)	±0.5 cm
5 μs	ccw	5 μs	1 kc	0.5μs	5 μs (10 cm)	±0.5 cm
5 μs	cw	5 μs	1 kc	5 μs	50 μs (10 cm)	±0.5 cm
0.05 ms	ccw	0.05 ms	0.1 kc	5 μs	50 μs (10 cm)	±0.5 cm
0.05 ms	cw	0.05 ms	0.1 kc	50 μs	0.5 ms	±0.5 cm
0.5 ms	ccw	0.5 ms	0.1 kc	50 μs	0.5 ms (10 cm)	±0.5 cm
0.5 ms	cw	0.5 ms	10 cps	0.5ms	5 ms (10 cm)	±0.5 cm

TABLE 4-6.

WIDTH CALIBRATION VERIFICATION

Width Range	Vernier Position	Pulse Delay	Rep Rate	Sweep Speed (per cm)	Width	Tolerance
0.05 μs	ccw	50 ns	0.1 mc	20 ns	20 ns (1 cm)	
0.05 μs	cw	50 ns	0.1 mc	50 ns	0.5 μs (10 cm)	±0.5 cm
0.5 μs	ccw	0.5 μs	10 kc	50 ns	0.5 μs (10 cm)	±0.5 cm
0.5 μs	cw	0.5 μs	10 kc	0.5μs	5 μs (10 cm)	±0.5 cm
5 μs	ccw	5 μs	1 kc	0.5μs	5 μs (10 cm)	±0.5 cm
5 μs	cw	5 μs	1 kc	5 μs	50 μs (10 cm)	±0.5 cm
0.05 ms	ccw	0.05 ms	0.1 kc	5 μs	50 μs (10 cm)	±0.5 cm
0.05 ms	cw	0.05 ms	0.1 kc	50 μs	0.5 ms (10 cm)	±0.5 cm
0.5 ms	ccw	0.5 ms	0.1 kc	50 μs	0.5 ms (10 cm)	±0.5 cm
0.5 ms	cw	0.5 ms	10 cps	0.5 ms	5 ms (10 cm)	±0.5 cm

TABLE 4-7.

TRANSITION TIME CALIBRATION VERIFICATION

Transition Time Range (μsec)	Leading Edge Vernier	Trailing Edge Vernier	Pulse Width	Rise Time (L.E.)(10%-90%)	Fall Time (T.E.)(10%-90%)
0.012-0.02	ccw	ccw	0.5 μsec	12 nsec	12 nsec
0.012-0.02	cw	cw	0.5 μsec	20 nsec	20 nsec
0.02-0.1	ccw	ccw	0.5 μsec	20 nsec	20 nsec
0.02-0.1	cw	cw	0.5 μsec	0.1 μsec	0.1 μsec
0.1-0.5	ccw	ccw	5 μsec	0.1 μsec	0.1 μsec
0.1-0.5	cw	cw	5 μsec	0.5 μsec	0.5 μsec
0.5-2.5	ccw	ccw	5 μsec	0.5 μsec	0.5 μsec
0.5-2.5	cw	cw	5 μsec	2.5 μsec	2.5 μsec
2.5-12.5	ccw	ccw	50 μsec	2.5 μsec	2.5 μsec
2.5-12.5	cw	cw	50 μsec	12.5 μsec	12.5 μsec

Delay Stability: With same setup as in the preceding paragraph, vary input voltage from 105 volts to 125 volts and verify that delay change is less than 2 cm (2%).

4.5.4 Pulse Width:

Pulse Width Timing:

a. Set pulse AMPLITUDE to 10 volts.

b. Set TRANSITION TIMES to minimum.

c. Set REPETITION RATE to 0.1 MC/S, vernier clockwise.

d. Sync oscilloscope from sync output.

e. View the positive pulse output (50 ohm termination).

f. Follow control settings on Table 4-6.

Pulse Width Duty Cycle:

a. Set REPETITION RATE to 0.1 MC/S, vernier clockwise.

b. Set PULSE DELAY to 0.05 MICROSEC, vernier clockwise.

c. Sync oscilloscope from positive sync output with sweep speed of 1 microsecond/cm.

d. View positive pulse output (50 ohm termination).

e. Set PULSE WIDTH to 0.5 MICROSEC, vernier counterclockwise. Slowly turn vernier clockwise and verify that 50% width duty cycle (5 microseconds) can be attained without circuit failure.

Pulse Width Jitter:

a. With controls set as in paragraph headed Pulse Width Duty Cycle (5 microsecond pulse width), set sweep to 0.5 microsecond/cm and expand to 50 nanosecond/cm.

b. View trailing edge of pulse and verify that jitter is less than 0.1 cm (0.1%).

Pulse Width Stability: With the same setup as in paragraph headed Pulse Width Jitter vary line voltage from 150 volts to 125 volts and verify that pulse width change is less than 2 cm (2%).

4.5.5 Main Pulse Output

Transition Time: See Figure 2-7 for proper oscilloscope interconnections. Note: Check to make certain that the oscilloscope smoothing controls are not limiting its bandpass.

a. Set REPETITION RATE to 10 KC/S, vernier clockwise.

b. Set PULSE DELAY to 0.05 MICROSEC, vernier approximately 10% rotated clockwise from full counterclockwise position.

c. Set PULSE WIDTH to 0.5 MICROSEC, vernier counterclockwise.

d. Set pulse AMPLITUDE at 50 volts, vernier clockwise to X1.

e. Follow control settings on Table 4-7.

Wave Shape: (See Figure 2-7 for proper oscilloscope interconnections).

a. Set REPETITION RATE to 0.1 MC/S, vernier counterclockwise.

b. Set PULSE DELAY to 0.05 MICROSEC, vernier approximately 10% rotated clockwise from full counterclockwise position.

c. Set PULSE WIDTH to 0.05 MICROSEC, vernier clockwise.

d. Set TRANSITION TIME vernier controls counterclockwise, RANGE switch to 0.02-0.1 MICROSEC range.

e. Set AMPLITUDE at 50 volts, vernier to X1.

f. Set overall oscilloscope sensitivity (attenuation of coaxial attenuators plus oscilloscope) to 2 volts/cm.

g. View the positive output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 0.75 cm in amplitude (3%).

h. View the negative output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 0.75 cm in amplitude (3%).

i. Set AMPLITUDE at 5.0 volts, vernier to X1.

j. Set oscilloscope sensitivity to 200 millivolts/cm.

k. View the positive output pulse and verify that the waveform aberrations a at the top and baseline of the pulse are less than 0.75 cm in amplitude (3%).

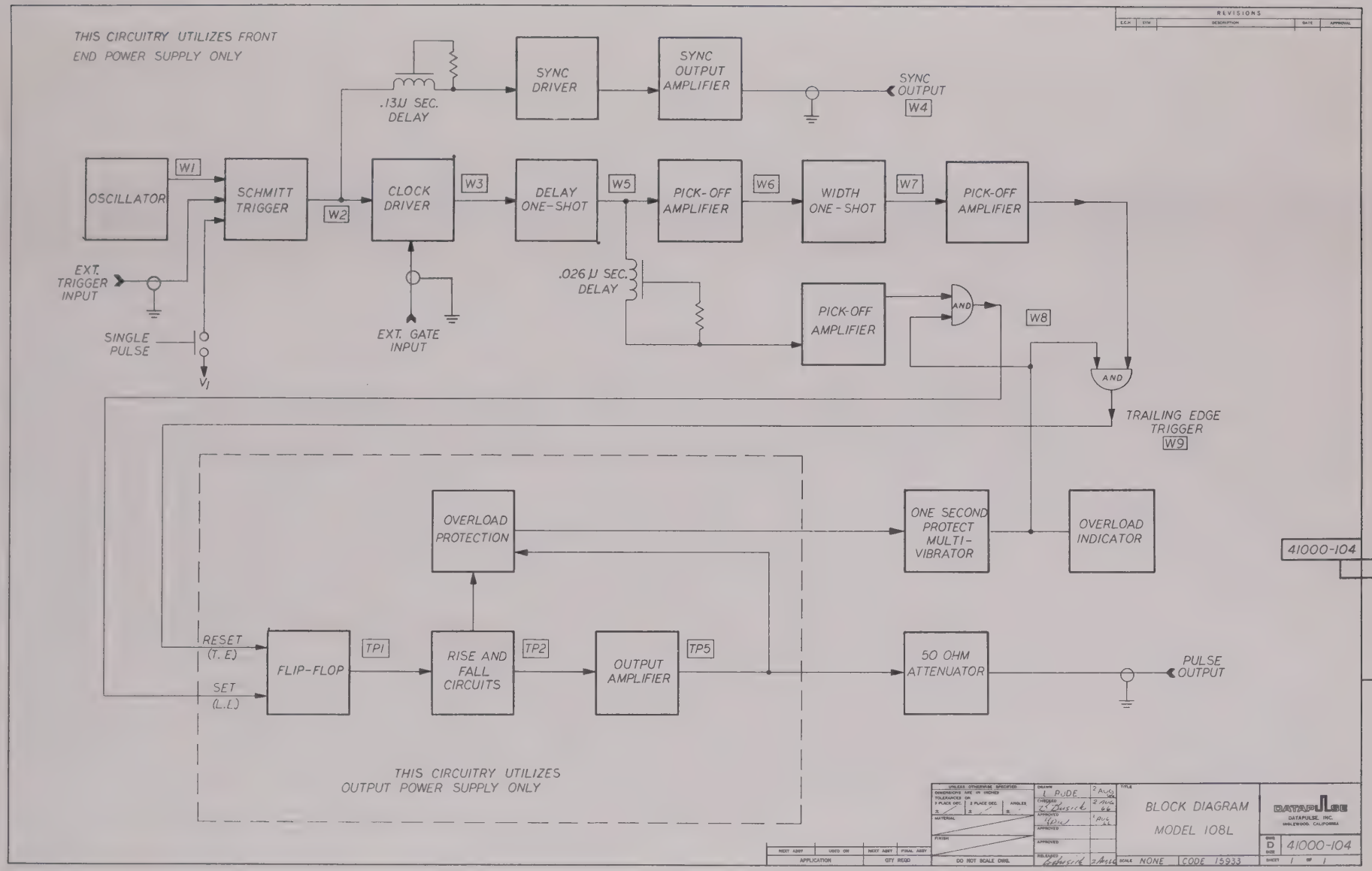
l. View the negative output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 0.75 cm in amplitude (3%).

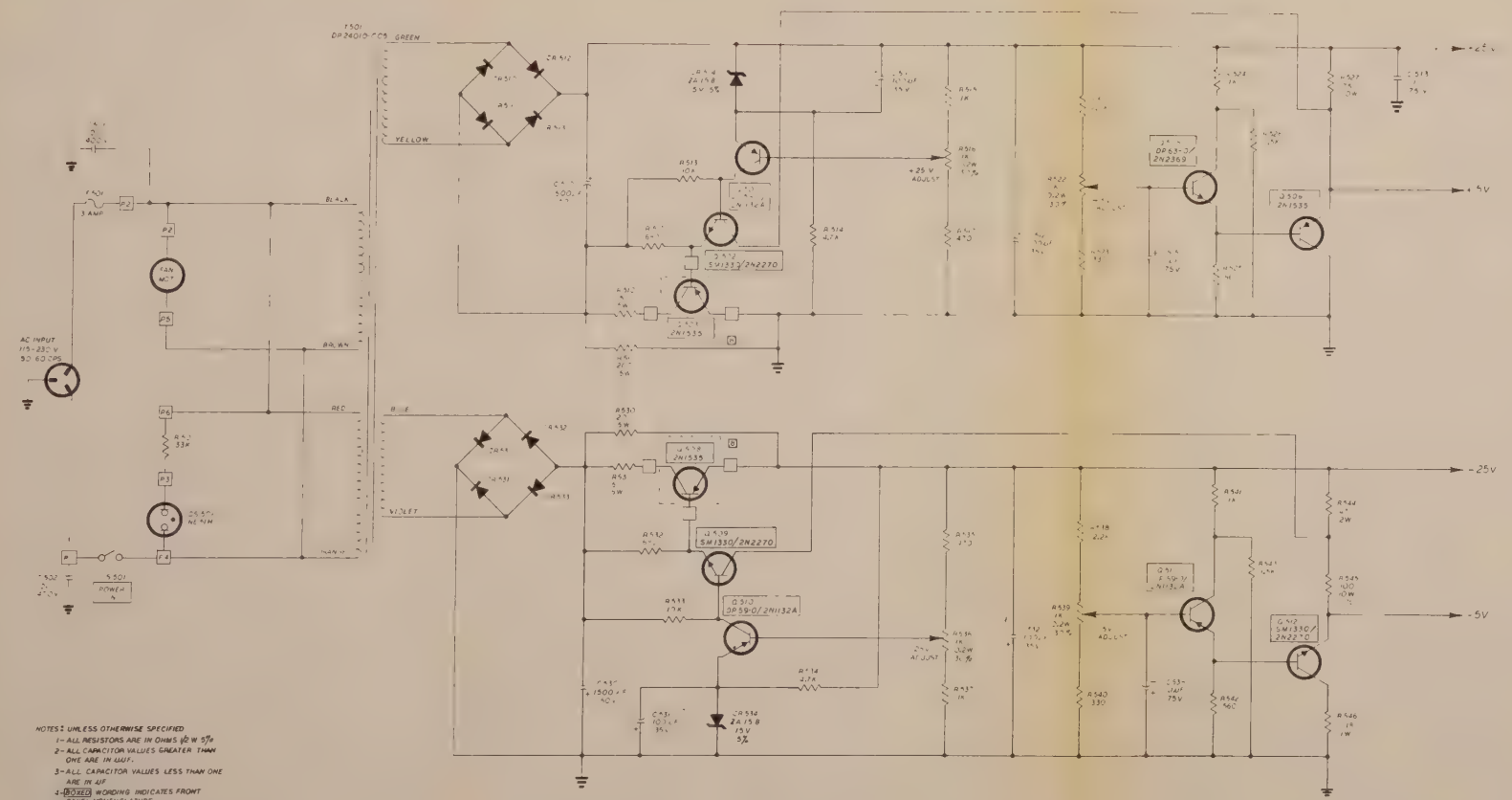
m. Set AMPLITUDE at 0.20 volts, ver-vernier to X1.

n. Set oscilloscope sensitivity to 10 millivolt/cm.

o. View the positive output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1.2 cm in amplitude (7%).

p. View the negative output pulse and verify that the waveform aberrations at the top and baseline of the pulse are less than 1.2 cm in amplitude.


THIS CIRCUITRY UTILIZES FRONT END POWER SUPPLY ONLY
.13μ SEC. DELAY
SYNC DRIVER
SYNC OUTPUT AMPLIFIER
SYNC OUTPUT
W4
OSCILLATOR
W1
SCHMITT TRIGGER
W2
CLOCK DRIVER
W3
DELAY ONE-SHOT
W5
PICK-OFF AMPLIFIER
W6
WIDTH ONE-SHOT
W7
PICK-OFF AMPLIFIER
EXT. TRIGGER INPUT
SINGLE PULSE
V1
EXT. GATE INPUT
.026μ SEC. DELAY
PICK-OFF AMPLIFIER
AND
W8
AND
TRAILING EDGE TRIGGER
W9
OVERLOAD PROTECTION
ONE SECOND PROTECT MULTI-VIBRATOR
OVERLOAD INDICATOR
RESET (T. E.)
SET (L. E.)
FLIP-FLOP
TP1
RISE AND FALL CIRCUITS
TP2
OUTPUT AMPLIFIER
TP5
50 OHM ATTENUATOR
PULSE OUTPUT
THIS CIRCUITRY UTILIZES OUTPUT POWER SUPPLY ONLY
REVISIONS
BLOCK DIAGRAM
MODEL 108L
41000-104
DATAPULSE, INC.
SCALE NONE
CODE 15933

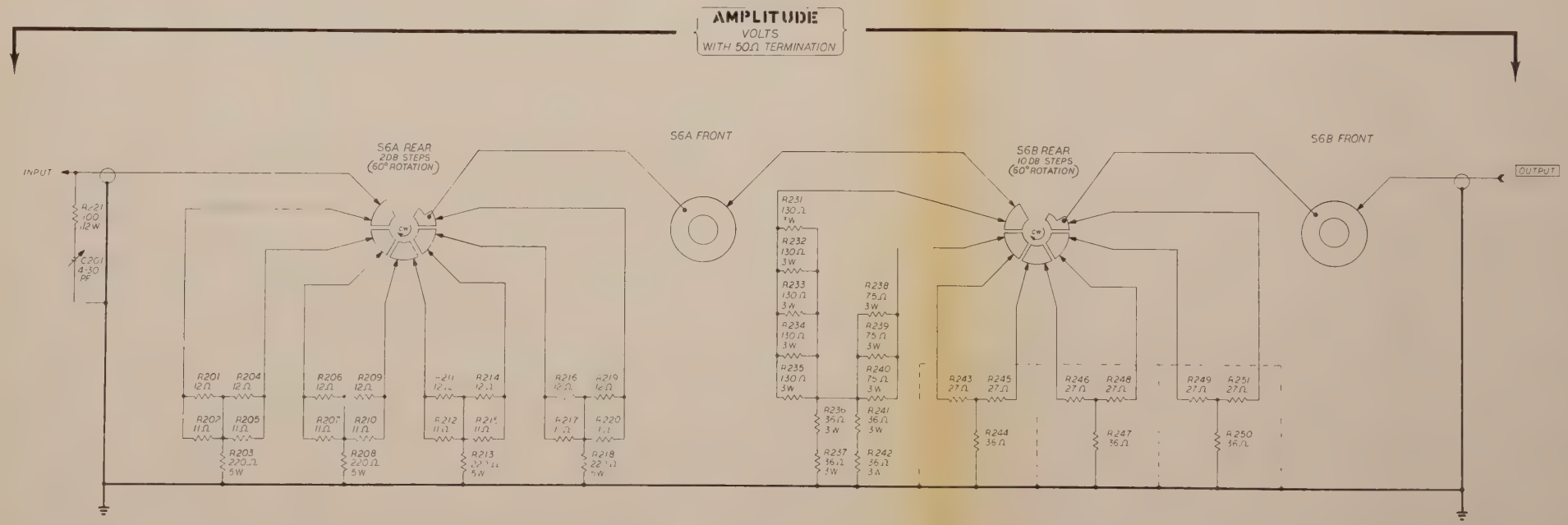


NOTES: UNLESS OTHERWISE SPECIFIED

1 - ALL RESISTORS ARE IN OHMS, ½ W 5%
2 - ALL CAPACITOR VALUES GREATER THAN ONE ARE IN MFD.
3 - ALL CAPACITOR VALUES LESS THAN ONE ARE IN MF
4 - [BOXED] WORDING INDICATES FRONT PANEL NOMENCLATURE
5 - [BOXED] LETTERS AND/OR NUMBERS INDICATE SPECIFIC LABELED POINTS ON CIRCUIT BOARD
6 - ALL DIODES ARE DP 19-1 / 1N4002
7 - T501 IS SHOWN CONNECTED FOR 115 VAC OPERATION
FOR 230 VAC OPERATION:
1. BREAK CONNECTION BETWEEN BLACK AND RED WIRES
2. BREAK CONNECTION BETWEEN BROWN AND ORANGE WIRES
3. CONNECT BROWN AND RED WIRES

[A] - Q903, Q908 ARE MOUNTED ON BACK PANEL

SCHEMATIC — POWER SUPPLY +5V & ±25V

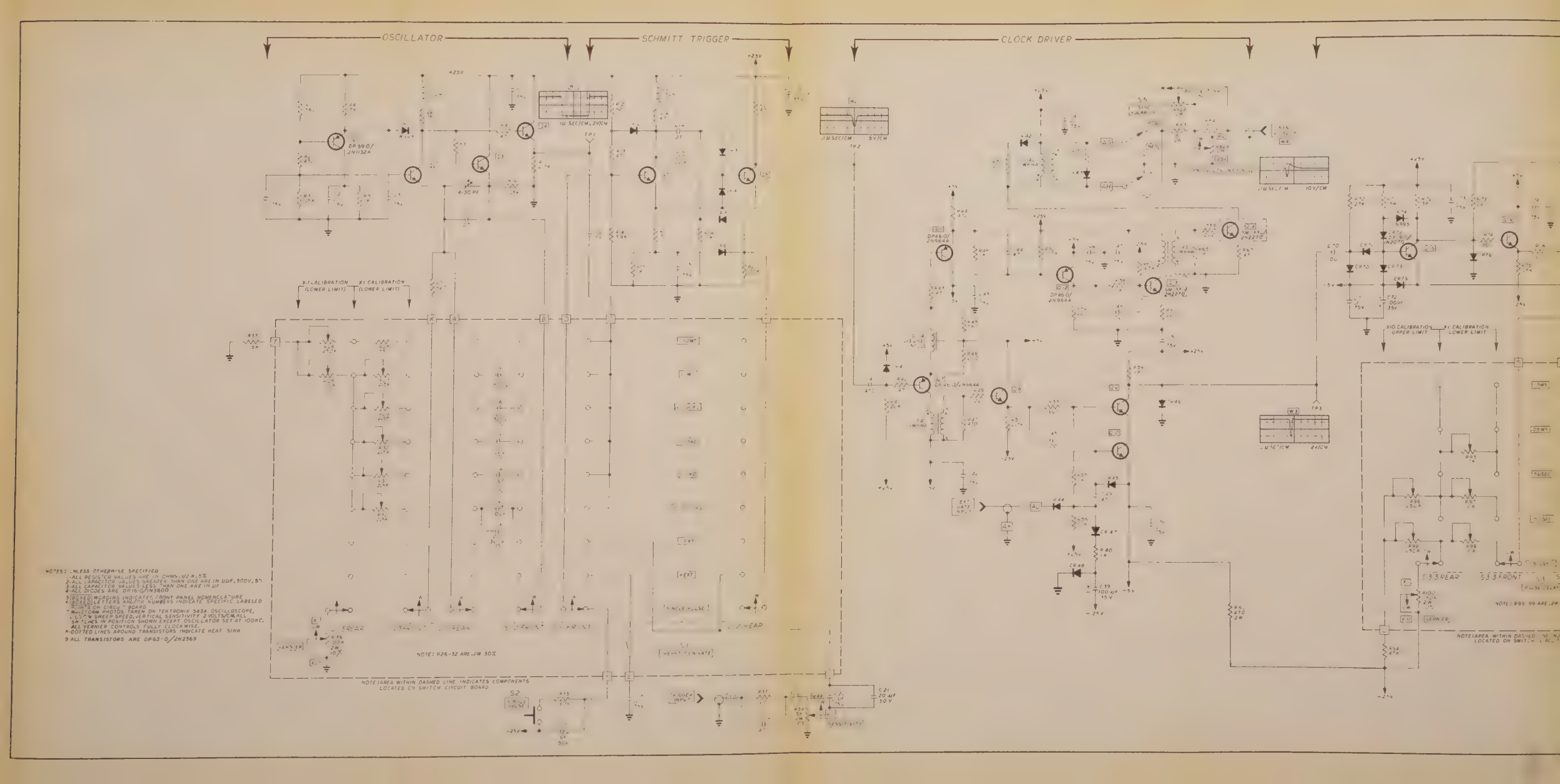


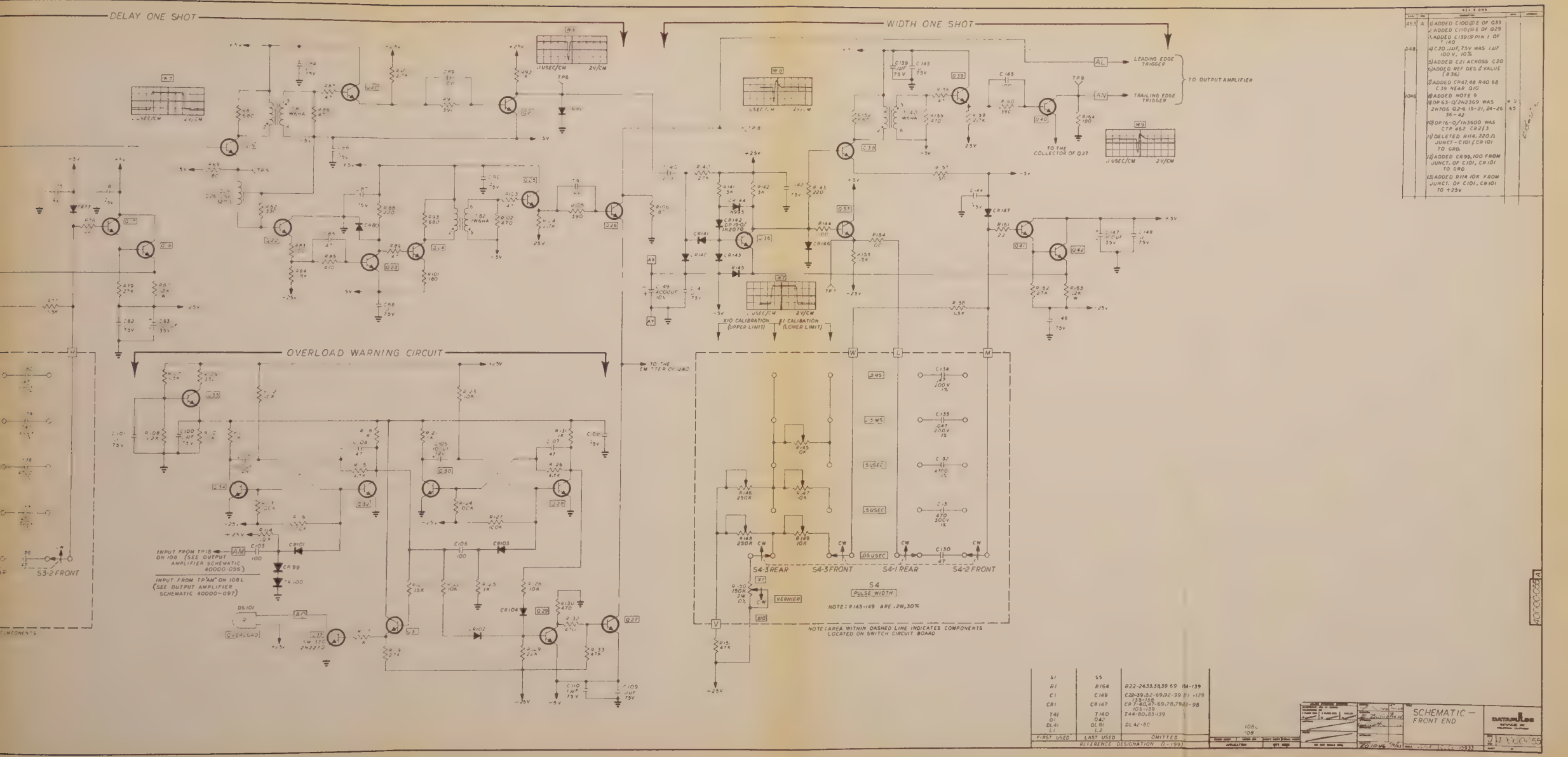
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE 2W, 5%
2. SWITCHES ARE SHOWN IN FULLY COUNTER CLOCKWISE POSITION AS VIEWED FROM CONTROL KNOB
3. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE

C201 5 R201	C201 6 R251	4222-230
FIRST USED	LAST USED	OMITTED
REFERENCE DESIGNATIONS		

SCHEMATIC – ATTENUATOR 5245L

DATAPULSE


OSCILLATOR
SCHMITT TRIGGER
CLOCK DRIVER
+25V
-25V
.1 SEC/CM, 2V/CM
.1 SEC/CM 5V/CM
.1 SEC/CM 10V/CM
.1 SEC/CM 2V/CM
TP1
TP2
TP3
DP59-0/ 2N1132A
4-30 PF
DP46-0/ 2N964A
2N2270
X.1 CALIBRATION (LOWER LIMIT)
X1 CALIBRATION (LOWER LIMIT)
X10 CALIBRATION UPPER LIMIT
X1 CALIBRATION LOWER LIMIT
CR46
CR47
CR48
CR70
CR71
CR72
CR73
CR74
CR75
R80 1K
R45 470 2W
R54 47K
C39 100 UF 15V
C21 20 UF 50V
S2
S3 READ
S3 FRONT
S3 REAR
S1
NOTE: R26-32 ARE .2W 30%
NOTE: AREA WITHIN DASHED LINE INDICATES COMPONENTS LOCATED ON SWITCH CIRCUIT BOARD
NOTES: UNLESS OTHERWISE SPECIFIED
1 ALL RESISTOR VALUES ARE IN OHMS, 1/2 W, 5%
2 ALL CAPACITOR VALUES GREATER THAN ONE ARE IN UUF, 500V, 5%
3 ALL CAPACITOR VALUES LESS THAN ONE ARE IN UF
4 ALL DIODES ARE DP16-0/1N3600
5 (BOXED) WORDING INDICATES FRONT PANEL NOMENCLATURE
6 (BOXED) LETTERS AND/OR NUMBERS INDICATE SPECIFIC LABELLED POINTS ON CIRCUIT BOARD
7 WAVEFORM PHOTOS TAKEN ON TEKTRONIX 543A OSCILLOSCOPE, WITH 5 MV SWEEP SPEED, VERTICAL SENSITIVITY 2 VOLTS/CM, ALL SWITCHES IN POSITION SHOWN EXCEPT OSCILLATOR SET AT 100KC, ALL VERNIER CONTROLS FULLY CLOCKWISE.
8 DOTTED LINES AROUND TRANSISTORS INDICATE HEAT SINK
9 ALL TRANSISTORS ARE DP63-0/2N2369


DELAY ONE SHOT
WIDTH ONE SHOT
OVERLOAD WARNING CIRCUIT
LEADING EDGE TRIGGER
TRAILING EDGE TRIGGER
TO OUTPUT AMPLIFIER
TO THE COLLECTOR OF Q27
TO THE EMITTER OF Q40
X10 CALIBRATION (UPPER LIMIT)
X1 CALIBRATION (LOWER LIMIT)
INPUT FROM TP18 ON 108 (SEE OUTPUT AMPLIFIER SCHEMATIC 40000-056)
INPUT FROM TP"AM" ON 108L (SEE OUTPUT AMPLIFIER SCHEMATIC 40000-097)
S3-2 FRONT
S4-3 REAR
S4-3 FRONT
S4-1 REAR
S4-2 FRONT
S4
PULSE WIDTH
VERNIER
NOTE: AREA WITHIN DASHED LINE INDICATES COMPONENTS LOCATED ON SWITCH CIRCUIT BOARD
NOTE: R145-149 ARE .2W, 30%

S1	S5	
R1	R164	R22-24,33,38,39,69 114-139
C1	C149	C28-39,52-69,92-99 111-129 133-138
CR1	CR147	CR 7-40,47-69,78,79,92-98 105-139
T41	T140	T44-80,83-139
Q1	Q42	
DL41	DL81	DL 42-80
L1	L2	
FIRST USED	LAST USED	OMITTED

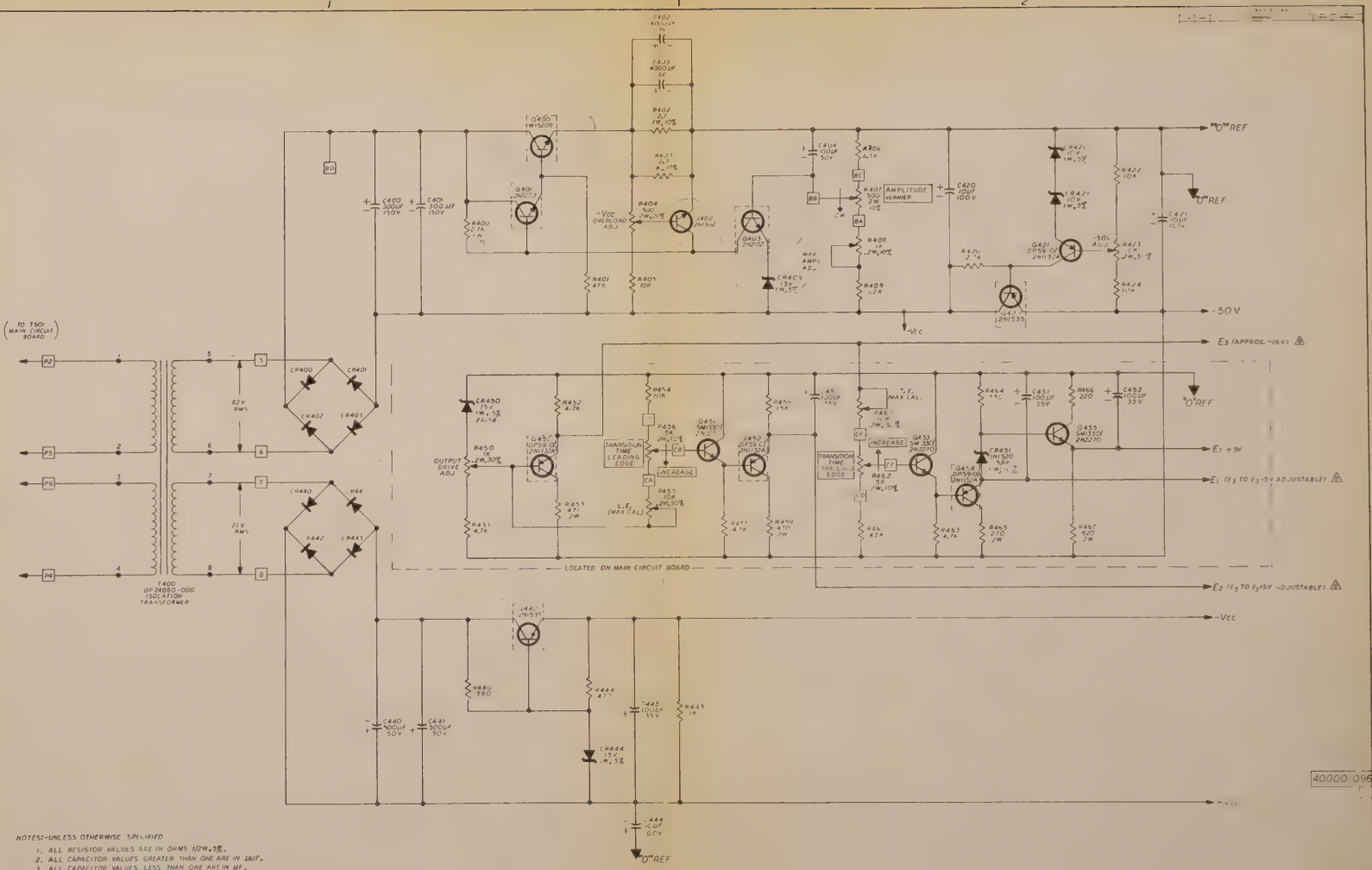
REFERENCE DESIGNATION (1-199)

108L
108

SCHEMATIC — FRONT END

DATAPULSE INC. MALIBU, CALIFORNIA

40000-055 A



NOTES: UNLESS OTHERWISE SPECIFIED

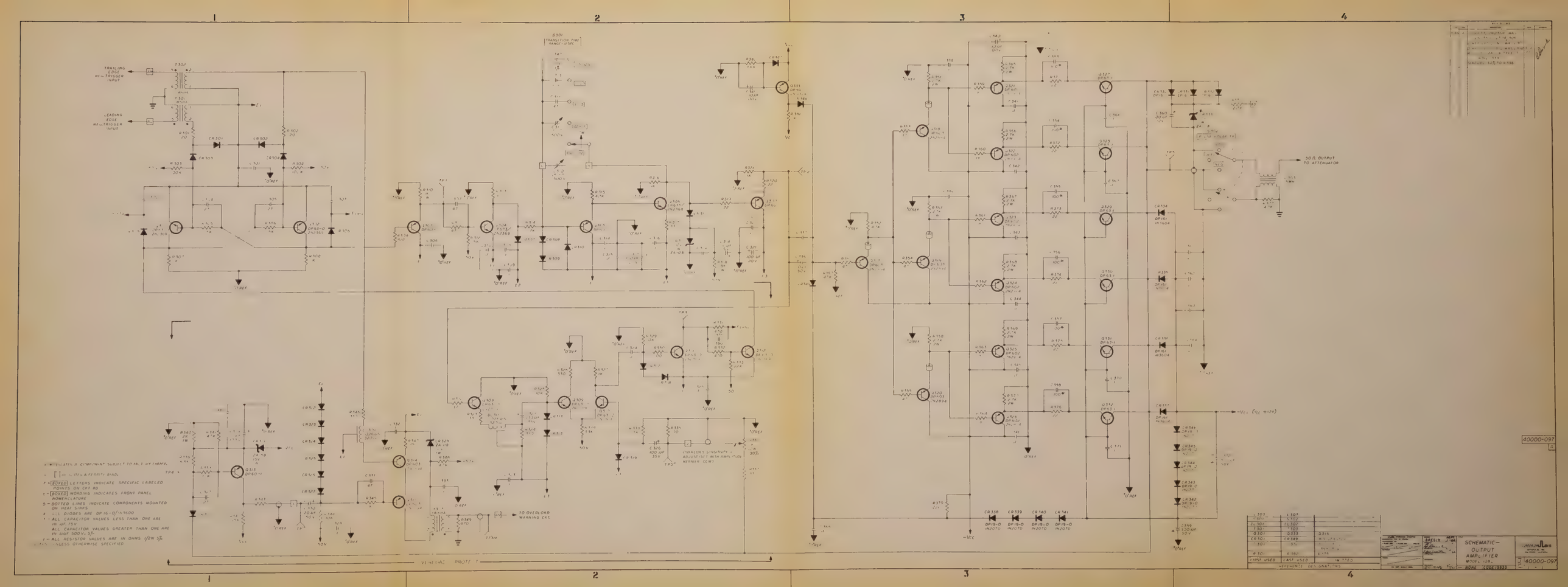
1. ALL RESISTOR VALUES ARE IN OHMS 1/2W, 5%.
2. ALL CAPACITOR VALUES GREATER THAN ONE ARE IN MMF.
3. ALL CAPACITOR VALUES LESS THAN ONE ARE IN MF.
4. ALL DIODES ARE DP49-1/1N4002
5. DOTTED LINES INDICATE COMPONENTS MOUNTED ON HEAT SINKS.
6. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
7. BOXED NUMBERS AND LETTERS INDICATE SPECIFIC LABELED POINTS ON CKT. BOARD.

⚠ E_3 IS APPROX. -16V;
E_2 IS VARIABLE FROM APPROX. E_3 TO E_3+5V & IS THE LEADING EDGE TRANSITION TIME CONTROL;
E_1 IS VARIABLE FROM APPROX. E_3 TO E_3 -5V & IS THE TRAILING EDGE TRANSITION TIME CONTROL.

FIRST USED	LAST USED	OMITTED
T400	T400	
Q400	Q455	Q404-419, 422-439, 441-449
CR400	CR451	CR404, 406-419, 422-439, 445-449
C400	C452	C405-419, 422-439, 442, 445-449
R400	R467	R410-419, 421, 425-439, 441, 442, 445-449

REFERENCE DESIGNATIONS

TITLE	SCHEMATIC – POWER SUPPLY OUTPUT AMPLIFIER
MODEL	1138
SIZE	NONE
CODE	19533
DRAWING NO.	40000-096
SHEET	1 of 1


TRAILING EDGE NEGATIVE TRIGGER INPUT
LEADING EDGE NEGATIVE TRIGGER INPUT
T302
T301
R301
R302
R303
R304
R305
R306
R307
R308
R309
R310
R311
R312
R313
R314
R315
R316
R317
R318
R319
R320
R321
R322
R323
R324
R325
R326
R327
R328
R329
R330
R331
R332
R333
R334
R335
R336
R337
R338
R339
R340

E. O. NO.	EFFECTIVE DATE	DWG. NO.	CHANGE
813A	1-4-66	J40000-096	Schematic: Output Power Supply 1. Delete C404 (100μf, 50V). 2. Change R404 (Var. Res.) to 1 k, 1/4 w, 5%, Fixed Carbon. 3. Change Q402 from 2N1302 to 2N-2270 and connect base lead to junction of R404 and R405. 4. Delete C402 and 403 (4000μf, 3V) 5. Change R400 from 2.7 k, 1 w, to 10 k, 1/2 w, 5%.
814A	1-10-66	J40000-097A	Schematic: Output Amplifier 1. Add CR315 and 316, diodes DP16-0 in series with CR313 and 314. 2. Change R359-364 from 18Ω to 22Ω, 1/2 w, 5%. 3. Delete the following, 1μf, 75V: C325, 333, 338, 339, 346, 348, 361, 362 and 363. 4. Add dotted lines around Q321-332 to indicate heat-sinks. 5. In reference designation block "omitted" add ref. des. of deleted capacitors listed on Item 3 of first part of this E.O. 6. Delete from "omitted" block ref. des. CR315, 316.
828A	1-25-66	J40000-097A	Schematic: Output Amplifier 1. Delete CR333 diode and install wire jumper. 2. Delete C359 capacitor. 3. Add ref. des. CR333 and C359 to "omitted" block.
826	1-25-66	J40000-055A	Change polarity of C83 to "positive to ground"; was "negative to ground."
855A	3-4-66	J40000-096	Schematic: Output Power Supply 1. Add Note 9: "DP63-1 may be a 2N3735." 2. Place Note 9 symbol after Q329-334.

E. O. NO.	EFFECTIVE DATE	DWG. NO.	CHANGE
855A	3-4-66	J40000-097A	Schematic: Output Amplifier 1. Add Note 10: "DP63-1 may be a 2N3735." 2. Place Note 10 symbol after Q327-332.
865	3-15-66	J40000-097A	Schematic: Output Amplifier 1. Change Q314, 315 from DP60-3 to DP60-5. 2. Change Q317-320 from DP60-3 to DP60-5.
885	4-13-66	J40000-055A	Schematic: Front End Change Q7, 11 and 12 from DP46-0 to DP60-6.
886	4-13-66	J40000-052A	Schematic: Power Supply Delete C501 and C502, 0.1μf, 400V, Cap.
2030	6-13-66	J40000-097	Schematic: Output Amplifier Add after Q7, 11 and 12: "DP60-6 may be 2N3640."
		J40000-055	Schematic: Front End Add after Q314, 315: "DP60-6 may be 2N3640."
2056	7-18-66	Photograph Figure 4-3.	Circuit Board, Calibration Sw. Ass'y 37000-122 Change R26, 10 mc, LL. Should read: Max. mc, LL.
2066	7-28-66	J40000-097A	Schematic - Output Amplifier Change Q327-332 from DP63-1, P/N 22635-001 to 2N3723, P/N 12635-001.
2012	5-11-66	Manual	(Incorporated in manual.)

ADDENDA AND ERRATA

E. O. NO.	EFFECTIVE DATE	DWG. NO.	CHANGE
2021	8-26-66	Transistor Equiv.	SM 1330, P/N 12685-004 is an acceptable substitute for DP63-6, P/N 22635-006.
2081	8-26-66	Transistor Substitution	2N2102, P/N 12685-005 may be used in lieu of 2N2270, P/N 12695-001.
2101	9-13-66	J40000-052A	Schematic - Power Supply Change Q505 transistor from DP63-0, P/N 22635-000 to DP63-4, P/N 22635-004.
2103	9-14-66	J40000-097A	Schematic - Output Amplifier 1. Change Q301, 302, 306, 308-312 from DP63-0 to DP63-4. 2. Change Q314-320 from DP60-3, P/N 22605-003 to DP60-5, P/N 22605-005. 3. Change Q327-332 from DP63-1, P/N 22635-001 to 2N3723, P/N 12635-001.
		J40000-055A	Schematic - Front End 1. Change Q2-5, 15-17, 19-32, 34, 36-41, 8-10 from DP63-0, P/N 22635-000 to DP63-4, P/N 22635-004. 2. Change Q6, 18, 35, 42 from DP63-0 to DP63-3, P/N 22635-003.
2183	1-13-67	J40000-055	Change C79, C133, .047μF, 200V, P/N 11124-473 to .047μF, 100V, P/N 11123-473.

DATAPULSE
DIVISION OF DATAPULSE INCORPORATED

SERVICE BULLETIN
NO. 1-65

SEMICONDUCTOR REPLACEMENTS

(Applicable to all Datapulse Models except the Model 100 and 102)

Datapulse makes extensive use of house labeled semiconductors, superseding or used in place of commercial equivalents. In most cases, these are procured against relaxed or actual commercial equivalent specifications, and commercial equivalents as listed below may, therefore, be used as replacements.

DATAPULSE TYPE NO.*	DATAPULSE PART NO.	COMMERCIAL EQUIVALENT
Diodes:		
DP16-0	22164-000	1N3600
DP16-1	22164-001	1N3604
DP16-2	22164-002	HPA1003
DP19-0	22194-000	1N2070
DP19-1	22194-001	1N4002
DP19-6	22194-006	1N2071
Transistors:		
DP43-0	22435-000	2N984
DP46-0	22465-000	2N964A
DP46-1	22465-001	None**
DP59-0	22595-000	2N1132A
DP60-0	22605-000	2N2411
DP60-1	22605-001	None**
DP60-2	22605-002	2N2904 or 2N3133
DP60-3	22605-003	2N2894
DP60-4	22605-004	2N3209
DP60-5	22605-005	FT1702
DP60-6	22605-006	2N3640
DP63-0	22635-000	2N2369 or 2N2501
DP63-1	22635-001	2N3723
DP63-2	22635-002	None**
DP63-3	22635-003	2N2369A
DP63-4	22635-004	2N3646 or 2N3605 or ME9021 or MPS3646
DP63-6	22635-006	2N2270

*Some earlier publications show Type No. without the dash.

**Replacements for the following items should be procured from Datapulse:

DP46-1 is selected from 2N2964A for high Beta.
DP60-1 is selected from 2N22894 for high V eco.
DP63-2 is selected from 2N914 for tighter Beta tolerance.

11/22/66

509 HINDRY AVENUE, INGLEWOOD, CALIFORNIA 90306 • TELEPHONE 671-4334 OR 678-4275 • TWX 910-328-6109

WARRANTY

Datapulse Incorporated warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, fuses or batteries which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been thus defective.

Instruments returned under this Warranty will not be accepted at the Datapulse plant without prior authorization by a Datapulse representative or by the service manager of Datapulse Incorporated.

Datapulse Incorporated reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Datapulse Incorporated and Datapulse Incorporated neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Datapulse Incorporated instruments.

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